

TECHNICAL SPECIFICATIONS FOR :

PROJECT: **MOUNT HOPE ELEMENTARY SCHOOL  
RENOVATION & ADDITION**

ADDRESS: MOUNT HOPE, ONTARIO

CLIENT: HAMILTON-WENTWORTH DISTRICT SCHOOL BOARD

PROJECT No.: 24114

DATE: NOVEMBER 2025

BINDER: **B** MECHANICAL & ELECTRICAL



ARCHITECT & CONSULTANTS:

**H** **HOSSACK**  
ARCHITECTURE

105-1939 IRONOK WAY  
OAKVILLE, ONTARIO L6H 3V8  
Tel (905) 815-8284

**DEI**  
Consulting Engineers  
MECHANICAL | ELECTRICAL | AQUATIC

55 Northland Road,  
Waterloo, ON, N2V 2Y8  
Phone: 519-725-3555  
Fax: 519-725-2515  
Website: deiasociates.ca  
Project Number: 22457

**KE** **KALOS**  
ENGINEERING

300 York Boulevard, Hamilton, ON L8R 3K6 905-333-9119

**MGM**  
CONSULTING INC

Consulting Engineering & Project Management  
400 Bronte Street South  
Suite 201  
Milton, Ontario  
L9T 0H7  
Tel: (905) 567-8678  
Fax: (905) 875-1339  
Email: mgm@mgm.on.ca  
www.mgm.on.ca

**FRP** inc.  
landscape.architects  
1877 Davenport Road  
Toronto, M6N 1B9  
www.frpinc.ca

## **Division 21 Fire Suppression**

### **Common Contract Requirements for Mechanical**

21 02 51 Fire Protection General Requirements

### **Facility Fire Suppression Water Service Piping**

21 05 48 Fire Protection Seismic Restraint

### **Fire Suppression Sprinkler Systems**

21 13 13 Wet Pipe Fire Suppression

## **Division 22 Plumbing**

### **Contract Requirements for Plumbing**

22 02 51 Plumbing General Requirements

### **Common Work Results for Plumbing**

22 05 11 Plumbing Work Requirements

22 05 31 Expansion Fittings and Loops

22 05 34 Plumbing Bases, Hangers, and Supports (Indoor)

22 05 48 Plumbing Seismic Restraint

22 05 49 Plumbing Vibration Control Measures

22 05 53 Identification of Plumbing Services

### **Commissioning for Plumbing**

22 05 65 Plumbing Contractor Commissioning Requirements

### **Common Work Results for Plumbing**

22 06 33 Heat Tracing for Plumbing & Drainage

### **Plumbing Insulation**

22 07 16 Plumbing Equipment Insulation

22 07 19 Plumbing Piping Insulation

### **Facility Water Distribution**

22 11 11 Site Services - Water Mains

22 11 16 Domestic Water Piping – Copper

22 11 20 Backflow and Cross Connection Measures

22 11 31 Potable Water Auxiliary Equipment

### **Facility Sanitary Sewerage**

22 13 11 Site Services - Sanitary Sewers

22 13 13 Sanitary Drains

22 13 16 Sanitary Waste and Vent Piping – Cast Iron and Copper

22 13 17 Sanitary Waste and Vent Piping – Plastic

22 13 23 Sanitary Interceptors

### **Facility Storm Drainage**

22 14 11 Site Services - Storm Sewers

22 14 15 Storm Drainage Piping – Cast Iron and Copper

22 14 16 Storm Drainage Piping - Plastic

22 14 26 Storm Drains

	<b>Fuel-Fired Domestic Water Heaters</b>
22 34 36	Fuel-Fired Domestic Water Heaters
	<b>Plumbing Auxiliary Equipment</b>
22 36 13	Plumbing Auxiliary Equipment
	<b>Fire Extinguishers</b>
22 37 13	Portable Fire Extinguishers
	<b>Plumbing Fixtures Combined With Drawing Schedule</b>
22 44 13	Plumbing Fixtures Combined With Drawing Schedule

## **Division 23 Heating, Ventilating, and Air Conditioning (HVAC)**

	<b>Common Contract Requirements for Mechanical</b>
23 02 51	HVAC General Requirements
	<b>Common Work for HVAC</b>
23 05 11	General HVAC Work Requirements
23 05 21	Demolition and Renovation
23 05 31	Expansion Fittings and Loops
23 05 32	Thermometers and Pressure Gauges
23 05 34	Bases, Hangers and Supports (Indoor)
23 05 35	Bases, Hangers, and Supports (Outdoor)
23 05 48	HVAC Seismic Restraint
23 05 49	Vibration Control Measures
23 05 53	Identification of HVAC Services
	<b>Common Work Results for HVAC</b>
23 06 81	Pipe Welding
	<b>Testing, Adjusting, and Balancing</b>
23 07 11	Testing, Adjusting, and Balancing (TAB) of HVAC Systems
	<b>Commissioning for Mechanical</b>
23 08 11	Mechanical Contractor Commissioning Requirements
	<b>HVAC Insulation</b>
23 10 13	Duct Insulation
23 10 16	HVAC Equipment Insulation
23 10 19	HVAC Piping Insulation
	<b>Facility Fuel Piping</b>
23 11 23	Facility Natural-Gas & Propane Piping
23 11 25	Natural Gas Piping Inspection and Testing
	<b>Hydronic Piping and Pumps</b>
23 21 11	Hydronic Accessories
23 21 13	Hydronic Piping - Screwed/Welded
23 21 23	Pumps Hydronic

	<b>HVAC Water Treatment</b>
23 25 13	Water Treatment for Closed-Loop Hydronic Systems
	<b>HVAC Ducts and Casings</b>
23 31 13	Metal Ducts
	<b>Air Plenums and Chases</b>
23 32 13	Fabricated, Metal Air Plenums
	<b>Air Duct Accessories</b>
23 33 13	Duct Accessories
23 33 14	Volume-Control Dampers
23 33 16	Fire Dampers
23 33 17	Smoke Control Dampers
23 33 18	Operating Dampers
23 33 46	Flexible Ducts
23 33 53	Duct Liners
	<b>HVAC Fans</b>
23 34 23	Packaged Exhausters
	<b>Air Terminal Units</b>
23 36 16	Variable-Air Volume Units
	<b>Air Outlets and Inlets</b>
23 37 13	Diffusers, Registers, and Grilles
23 37 23	Louvres, Intakes, and Exhaust
	<b>Breeching, Chimneys, and Stacks</b>
23 51 33	Insulated Sectional Chimneys
	<b>Heating Boilers</b>
23 52 13	Stainless Steel Fire Tube Condensing Boilers
	<b>Packaged Outdoor HVAC Equipment</b>
23 74 45	Packaged Air Source Rooftop HVAC Units with Back-Up Gas Heat
	<b>Convection Heating and Cooling Units</b>
23 82 29	Radiators, Convectors, and Cabinet Heaters
23 82 31	Hydronic Radiant Ceiling Panels

## **Division 25 Integrated Automation**

	<b>Other Integrated Automation Components</b>
25 05 11	Variable Frequency Drives (VFD)
	<b>Building Automation System</b>
25 20 11	Building Automation System

**END OF SECTION**



**Part 1            General**

**1.1            GENERAL PROVISIONS**

- .1      Conform to Division 1 General Conditions and to all sections of Mechanical Division.
- .2      Furnish labour, materials, and equipment necessary for completion of work as described in contract documents.
- .3      Unless specifically indicated, all materials and equipment provided under this contract shall be new and shall be manufactured in the project year.
- .4      The term “Mechanical Contractor” shall remain active and shall mean a “single contractor” performing plumbing, drainage, heating, cooling, ventilation, and control services.
- .5      When quoting as a subcontractor this contractor shall explicitly state the services they are providing i.e. Mechanical (all services), Plumbing (water and drainage systems) or HVAC (including hydronic and air systems).
- .6      Contractors shall be explicit to identify whether Fire Protection is included or omitted from the mechanical scope.

**1.2            INTENT**

- .1      Mention herein or indication on Drawings of articles, materials, operations or methods requires: supply of each item mentioned or indicated, of quality, or subject to qualifications noted; installation according to conditions stated: and, performance of each operation prescribed with furnishing of necessary labour, equipment, and incidentals for fire protection work.
- .2      Where used, words “Section” and “Division” shall also include other Subcontractors engaged on site to perform work to make building and site complete in all respects.
- .3      Where used, word “supply” shall mean furnishing to site in location required or directed complete with accessory parts.
- .4      Where used, word “install” shall mean secured in place and connected up for operation as noted or directed.
- .5      Where used, word “provide” shall mean supply and install as each is described above.

**1.3            REGULATIONS, PERMITS, AND FEES**

- .1      All materials and quality of work shall meet all current and latest Provincial, Municipal and Fire Marshall requirements, regulations, codes, and by-laws in force in the area of the project.
- .2      Each contractor shall give all necessary notices, obtain all necessary permits, and pay all fees in order that the work shown or specified may be carried out. Each contractor shall furnish any certificates necessary as evidence that the work installed conforms with the laws and regulations of all authorities having jurisdiction.

- .3 In the event that changes, or alterations are required on completed work by authorized inspectors, these changes shall be made at the contractor's expense.
- .4 Special equipment which does not have a standard CSA label shall be inspected by the local electrical authority having jurisdiction and the Approval Certificate shall be submitted to the Consultant as soon as possible. All costs and fees for inspections shall be borne by this contractor.

#### **1.4 DRAWINGS**

- .1 The drawings and this specification have been assembled together as a responsibility of the consultant. The same is true for the other consultants, i.e. architect, structural engineer, civil engineer, fire protection engineer, electrical engineer, etc.
- .2 The drawings and specifications are not assembled together for responsibility/division between subcontractors. The division of work between subcontractors remains the responsibility of the buildings' contractor (also known as the prime contractor or general contractor).
- .3 All subcontractors are encouraged to perform work amicably utilizing all of the drawings and specifications published by all of the consultants.
- .4 Fire protection drawings do not show architectural, structural, plumbing, mechanical and related details. Take information involving accurate measurement of building from building drawings, or at building. Make, without additional charge, any necessary changes, or additions to runs of piping, conduits, and ducts to accommodate structural conditions. Location of pipes and other equipment may be altered by Consultant without extra charge provided change is made before installation and does not necessitate major additional material.
- .5 As work progresses and before installing piping and any other fittings and equipment which may interfere with interior treatment and use of building, provide detail drawings, or obtain directions for exact location of such equipment and fittings.
- .6 Install piping clear structural members and any fireproofing. Locate work to permit installation of specified insulation. Do not remove or damage structural fireproofing. Leave space to permit fireproofing and insulation to be inspected and repaired.
- .7 Before commencing work, check and verify all sizes, locations, grade and invert elevations, levels, and dimensions to ensure proper and correct installation.
- .8 Locate all fire protection piping and equipment in such a manner as to facilitate easy and safe access to and maintenance and replacement of any part.
- .9 In every place where there is indicated space reserved for future or other equipment, leave such space clear, and install piping and other work so that necessary installation and connections can be made for any such apparatus. Obtain instructions whenever necessary for this purpose.
- .10 Relocate equipment and/or material installed but not co-ordinated with work of other Sections and/or installed incorrectly as directed, without extra charge.
- .11 Where drawings are done in metric and product not available in metric, the corresponding imperial trade size shall be utilized.

## **1.5 INTERFERENCE AND COORDINATION DRAWINGS**

- .1 Prepare interference and equipment placing drawings to ensure that all components will be properly accommodated within the constructed spaces provided.
- .2 Prepare drawings to indicate co-ordination and methods of installation of a system with other systems where their relationship is critical. Ensure that all details of equipment apparatus, and connections are coordinated.
- .3 Ensure that clearances required by jurisdictional authorities and clearances for proper maintenance are indicated on drawings.
- .4 Upon consultant's request submit copies of interference drawings to consultant.
- .5 Due to the nature of the building and the complexity of the building systems provide the following:
  - .1 Interference drawings, showing coordination of architectural, structural, plumbing, mechanical, and electrical systems for the consultant's review prior to fabrication.
  - .2 Detailed layout drawings, clearly showing fasteners and hangers.
- .6 Provide CAD drawings (minimum file version AutoCAD 2013) in addition to hard copies.

## **1.6 QUALITY ASSURANCE**

- .1 Perform work in accordance with applicable provisions of local Code and NFPA requirements. Ordinances, and adoptions thereof for all fire protection systems. Provide materials and labor necessary to comply with rules, regulations, and ordinances.
- .2 In case of differences between building codes, provincial laws, local ordinances, utility company regulations, and Contract Documents, the most stringent shall govern. Promptly notify Consultant in writing of such differences.

## **1.7 EXAMINATION**

- .1 Site Reviews
  - .1 Examine premises to understand conditions, which may affect performance of work of this Division before submitting proposals for this work.
  - .2 No subsequent allowance for time or money will be considered for any consequence related to failure to examine site conditions.
- .2 Ensure that items to be furnished fit space available. Make necessary field measurements to ascertain space requirements including those for connections and furnish and install equipment of size and shape so final installation shall suit true intent and meaning of Contract Documents. If approval is received by Addendum or Change Order to use other than originally specified items, be responsible for specified capacities and for ensuring that items to be furnished will fit space available.

## **1.8 SEQUENCING, SCHEDULING, AND COORDINATION**

- .1 It is understood that while Drawings are to be followed as closely as circumstances permit, this Division will be held responsible for installation of systems according to the true intent and meaning of Contract Documents. Anything not clear or in conflict will be explained by making application to Consultant. Should conditions arise where certain changes would be advisable, secure Consultant's approval of these changes before proceeding with work.
- .2 Coordinate work of various trades in installing interrelated work. Before installation of fire protection items, make proper provision to avoid interferences in a manner approved by Consultant. Each Contractor shall refer to all sections of the specification for their responsibilities with other trades. Changes required in work specified in Fire Protection Division caused by neglect to do so shall be made at no cost to Owner.
- .3 Arrange pipes, ducts, and equipment to permit ready access to valves, unions, traps, starters, motors, control components, and to clear openings of doors and access panels.
- .4 Furnish sleeves, inserts, supports, and equipment that are an integral part of other Divisions of the Work to Sections involved in sufficient time to be built into construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne by Fire Protection Division.
- .5 Be responsible for required cutting, and patching incident to work of this Division and make required repairs afterwards to satisfaction of Consultant. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses.
  - .1 Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
  - .2 Each Section of this Division shall bear expense of cutting, patching, repairing, and replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.
- .6 Adjust locations of pipes, equipment, fixtures, etc, to accommodate work from interferences anticipated and encountered. Determine exact route and location of each pipe prior to fabrication.
  - .1 Make offsets, transitions, and changes in direction of pipes as required to maintain proper head room and pitch of sloping lines whether or not indicated on Drawings.
- .7 Slots and openings through floors, walls, and ceilings shall be provided by this contractor but performed by a trade specializing in this type of work. This Division shall see that they are properly located and do any cutting and patching caused by its neglect to do so.

## **1.9 REQUEST FOR INFORMATION (RFI) PROCEDURES**

- .1 RFIs shall be submitted to the consultant minimum two (2) weeks prior to answer being required. Failure to submit an RFI in a timely manner will forfeit delay claims and schedule extension requests by the contractor.

.2 All RFIs will be submitted with the following information:

- .1 RFI number
- .2 Name of project
- .3 Date of initiation
- .4 Date response required by (minimum two (2) weeks)
- .5 Subject
- .6 Submitter's name
- .7 Drawing/specification reference
- .8 Photograph of the issue (if applicable)
- .9 Description of the issue
- .10 Contractor's proposed resolution

#### **1.10 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Furnish complete catalog data for manufactured items of equipment to be used in the Work to Consultant for review within 14 days after award of Contract.
- .2 Upon receipt of reviewed shop drawing, product is to be ordered immediately.
- .3 Provide a complete list of shop drawings to be submitted prior to first submission.
- .4 Before submitting to the Consultant, review all shop drawings to verify that the products illustrated therein conform to the Contract Documents. By this review, the Contractor agrees that it has determined and verified all field dimensions, field construction criteria, materials, catalogue numbers, and similar data and that it has checked and coordinated each shop drawing with the requirements of the work and of the Contract Documents. The Contractor's review of each shop drawings shall be indicated by stamp, date and signature of a qualified and responsible person possessing by the appropriate authorization.
- .5 If material or equipment is not as specified or submittal is not complete, it will be rejected by Consultant.
- .6 Additional shop drawings required by the contractor for maintenance manuals, site copies etc., shall be photocopies of the "reviewed" shop drawings. All costs to provide additional copies of shop drawings shall be borne by the contractor.
- .7 Submit all shop drawings for the project as a package. Partial submittals will not be accepted.**
- .8 Catalog data or shop drawings for equipment, which are noted as being reviewed by Consultant or their Engineer shall not supersede Contract Documents.
- .9 Review comments of Consultant shall not relieve this Division from responsibility for deviations from Contract Documents unless Consultant's attention has been called to such deviations in writing at time of submission, nor shall they relieve this Division from responsibility for errors in items submitted.
- .10 Check work described by catalog data with Contract Documents for deviations and errors.

- 
- .11 Shop drawings and product data shall show:
    - .1 Mounting arrangements.
    - .2 Operating and maintenance clearances. e.g., access door swing spaces.
  - .12 Shop drawings and product data shall be accompanied by:
    - .1 Detailed drawings of bases, supports, and anchor bolts.
    - .2 Acoustical sound power data, where applicable.
    - .3 Points of operation on performance curves.
    - .4 Manufacturer to certify as to current model production.
    - .5 Certification of compliance to applicable codes.
  - .13 State sizes, capacities, brand names, motor HP, accessories, materials, gauges, dimensions, and other pertinent information. List on catalog covers page numbers of submitted items. Underline applicable data.
  - .14 Shop drawings shall be submitted electronically as per the following directions:
    - .1 Electronic Submissions:
      - .1 Electronically submitted shop drawings shall be prepared as follows:
        - .1 Use latest software to generate PDF files of submission sheets.
        - .2 Scanned legible PDF sheets are acceptable. Image files are not acceptable.
        - .3 PDF format shall be of sufficient resolution to clearly show the finest detail.
        - .4 PDF page size shall be standardized for printing to letter size (8.5"x11"), portrait with no additional formatting required by the consultant. Submissions requiring larger detail sheets shall not exceed 11"x17".
        - .5 Submissions shall contain multiple files according to section names as they appear in Specification.
        - .6 File names shall include consultant project number and description of shop drawing section submitted.
        - .7 Each submission shall contain an index sheet listing the products submitted, indexed in the same order as they appear in the Specification. Include associated PDF file name for each section.
        - .8 On the shop drawing use an "electronic mark" to indicate what is being provided.
        - .9 **Each file shall bear an electronic representation of the "company stamp" of the contractor. If not stamped the file submission will not be reviewed.**
      - .2 Email submissions shall include subject line to clearly identify the consultants project number and the description of the shop drawings submitted.

- .3 Electronic attachments via email shall not exceed 10MB. For submissions larger than 10MB, multiple email messages shall be used. Denote related email messages by indicating “1 of 2” and “2 of 2” in email subject line for the case of two messages.
- .4 Electronic attachments via web links (URL) shall directly reference PDF files. Provide necessary access credentials within link or as username/password clearly identified within body of email message.
- .5 On site provide one copy of the “reviewed” shop drawings in a binder as noted above.
- .6 Contractor to print copies of “reviewed” shop drawings and compile into maintenance manuals in accordance with requirements detailed in this section.

#### **1.11 EQUIPMENT NAMEPLATE DATA**

- .1 Between the manufactures design published literature, the shop drawing submission literature, and the nameplate data on the equipment, they can all read differently.
- .2 Most of the confusion and differences are coming out of the electrical power installation.
- .3 The contractors installing and connecting the equipment are responsible for the coordination of this data through the construction period.
- .4 The contractors shall share and/or request this information through out the project and monitor/make adjustments, provide recommendations accordingly based on any discrepancies.
- .5 The contractors are responsible for any cost associated with the changing data.
- .6 The final installation must meet the “Nameplate Data” on the equipment on site.

#### **1.12 OPERATION AND MAINTENANCE MANUAL**

- .1 Provide operation and maintenance data for incorporation into manual as in submittals’ requirements.
- .2 Operation and maintenance manual to be approved by, and final copies deposited with, Consultant before final inspection.
- .3 Submit 1 copy of Operation and Maintenance Manual to Consultant for approval. Submission of individual data will not be accepted unless so directed by Consultant. Submission can be done electronically in pdf format or as a hardcopy.
  - .1 Electronic submission/pdf file is required to be bookmarked. Any submission received without bookmarking will be immediately returned as unacceptable.
  - .2 Hardcopy submission shall be in a three-ring binder (minimum 50 mm (2") ring) and labelled as ‘Operation and Maintenance Manual’ with project name and location. Dividers are to be used for binder organization.
- .4 Make changes as required and re-submit as directed by Consultant.

---

**1.13 AS-BUILT DRAWINGS**

- .1 Site records:
  - .1 Contractor shall provide 2 sets of reproducible fire protection drawings. Provide sets of white prints as required for each phase of the work. Mark thereon all changes as work progresses and as changes occur. This shall include changes to existing fire protection systems, control systems and low voltage control wiring.
  - .2 On a weekly basis, transfer information to reproducibles, revising reproducibles to show all work as actually installed.
  - .3 Use different colour waterproof ink for each service.
  - .4 Make available for reference purposes and inspection at all times.

**1.14 WARRANTIES**

- .1 In addition to guarantee specified in General Conditions, guarantee fire protection systems to be free from defects that may develop from failure to construct system in accordance with Contract Documents.
- .2 Provide certificates of warranty for each piece of equipment made out in favor of Owner. Clearly record "start-up" date of each piece of equipment on certificate. Include certificates as part of Operation & Maintenance Manual.
- .3 Warranty period shall start from date of ready for takeover.

**1.15 OCCUPANCY REQUIREMENTS**

- .1 The contractor shall provide the following documentation to the consultant's satisfaction prior to receiving occupancy. Failure to provide the proper documentation will result in the occupancy not being granted. List of required documentation:
  - .1 Final Certificates (required prior to consultant's release of conformance letter).
    - .1 NFPA-13 Contractors Material and Test Certificate (sprinkler)
    - .2 NFPA-14 Contractors Material and Test Certificate (standpipe)
    - .3 Sprinkler/Standpipe Design Engineers' Letter
    - .4 System has been tested with the Integrated Testing Contractor.
    - .5 Engineer's seismic restraint letter.

**1.16 READY FOR TAKEOVER**

- .1 Complete the following to the satisfaction of the consultant prior to request for ready for takeover.
  - .1 As-Built Drawings.
  - .2 Maintenance Manuals
  - .3 System Start up
  - .4 Instructions to Owners



**1.17 REVISION TO CONTRACT**

- .1 Provide the following:
  - .1 Itemized list of material with associated costs.
  - .2 Labour rate and itemized list of labour for each item.
  - .3 Copy of manufacturers/supplier's invoice if requested.

**1.18 DELIVERY, STORAGE, AND HANDLING**

- .1 Follow Manufacturer's directions in delivery, storage, and protection, of equipment and materials. Contractor to include all costs associated with delivery storage and handling in tender price.
- .2 Deliver equipment and material to site and tightly cover and protect against dirt, water, chemical, and other environment damaging conditions but have readily accessible for inspection. Store items subject to moisture damage (such as controls) in dry, heated space.
- .3 Remove any damaged materials from site.

**1.19 DESIGNATED SUBSTANCES AND HAZARDOUS MATERIALS**

- .1 **If designated substances and/or hazardous materials are suspected or identified cease all work in the immediate area in accordance with OHSA and notify consultant.**
- .2 **Each contractor and on site employee of the contractor shall have "asbestos awareness training".**
- .3 The Contractor shall ensure that employees who may come into contact with designated substances and/or hazardous materials due to the nature of the work that they perform, have received training that enables them to recognize designated substances and/or hazardous materials and that enables them to react in accordance with the Occupational Health and Safety Act and regulations thereto should contact with designated substances and/or hazardous materials occur during the course of their work.
- .4 **It is the responsibility of the contractor to review the designated substances and/or hazardous materials book in the building prior to starting any work.**
- .5 **Existing occupied buildings (depending upon their age) may contain designated substances and/or hazardous materials in thermal insulating materials and some manufactured products, such as vinyl asbestos floor tile. Any insulating materials, on pipes, fittings, boilers, tanks, ductwork, etc. may contain designated substances and/or hazardous materials and shall not be disturbed.**
- .6 **A survey of each building documenting the location and condition of designated substances and/or hazardous materials -containing materials is available for your mandatory review prior to commencing any work on premises.**

---

**1.20 PHASING OF WORK**

- .1 This work for this project shall be constructed in phases. Refer to the architectural drawings for phasing information and details. Misinterpretation of the drawings with respect to the extent of the phasing of the work shall not relieve the contractor of the work required to complete the entire contract.
- .2 Provide all necessary services or temporary services to suit phasing of construction with respect to all fire protection systems.
- .3 Life safety systems in the building are to remain fully operational in occupied areas for building staff and occupants during renovations.
- .4 Provide all necessary tests and certificates at completion of each phase to suit requirements of local authorities and consultants for occupancy of completed areas.

**1.21 CONFINED SPACES**

- .1 Certain areas of the building may be defined as a “Confined Space”. Any personnel working in these areas must have confined space training, appropriate equipment and undertake all work in conformance with appropriate codes and standards.
- .2 Refer to building documentation for any spaces deemed “Confined Space”.

**1.22 TESTS**

- .1 Give 48 hours written notice of date for tests.
- .2 Insulate or conceal work only after testing and approval by Consultant.
- .3 Conduct tests in presence of Consultant.
- .4 Bear costs including retesting and making good.
  - .1 Test fire systems in accordance with authorities having jurisdiction and as specified elsewhere.
- .5 Test fire systems in accordance with authorities having jurisdiction (AHJ) NFPA requirements and as specified elsewhere.
- .6 Equipment: test as specified in relevant sections.
- .7 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures or test medium.

**1.23 TRIAL USAGE**

- .1 Consultant or owner may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Trial usage to apply to all fire protection.

---

**1.24 ELECTRICAL**

- .1 Electrical work to conform to Electrical Division including the following:
  - .1 Power wiring and conduit is specified in Electrical Division except for conduit, wiring and connections below 50 V which are related to control systems. Follow Electrical Division for installation methods, quality of materials, and workmanship.
  - .2 Electrically operated equipment shall be C.S.A. approved label. Special Inspection Label of Provincial Authority having jurisdiction will be accepted in lieu of C.S.A. approval. Each motor shall have an approved starter. Starter will be supplied and installed by Electrical Division unless otherwise indicated.

**1.25 PIPING AND EQUIPMENT SUPPORTS**

- .1 Equipment supports supplied by equipment manufacturer shall follow the manufacturer's recommendation.
- .2 Piping and equipment supports not supplied by equipment manufacturer: fabricate from structural grade steel meeting requirements of - Structural Steel Section. Submit structural calculations with shop drawings.

**1.26 SLEEVES**

- .1 Pipe sleeves: at points where pipes pass through masonry, concrete or fire rated assemblies and as indicated. Grout sleeves in place.
- .2 Schedule 40 steel pipe.
- .3 Sleeves with annular fin continuously welded at midpoint:
  - .1 Through foundation walls.
  - .2 Where sleeve extends above finished floor.
  - .3 Through fire rated walls and floors.
- .4 Sizes: minimum 6 mm (1/4") clearance all around, between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Terminate sleeves flush with surface of concrete and masonry walls, concrete floors on grade and 25 mm (1") above other floors.
- .6 Fill voids around pipes:
  - .1 Caulk between sleeve and pipe in foundation walls and below grade floors with waterproof fire retardant non-hardening mastic.
  - .2 Where sleeves pass through walls or floors, provide space for firestopping. Where pipes/ducts pass through fire rated walls, floors and partitions, maintain fire rating integrity.
  - .3 Ensure no contact between copper tube or pipe and ferrous sleeve.
  - .4 Fill future-use sleeves with lime plaster or other easily removable filler.
  - .5 Coat exposed exterior surfaces of ferrous sleeves with heavy application of zinc rich paint to CGSB 1-GP-181M+Amdt-Mar-78.

- .7 Provide minimum 20 gauge duct sleeves where ducts pass through masonry concrete or fire rated assemblies. Maintain minimum 25 mm clearance all around or to the requirements of the authority having jurisdiction. Seal at wall as indicated.

#### **1.27 FIRE STOPPING**

- .1 This contractor shall work with all other contractors on the project in providing one common method of fire stopping all penetrations made in fire rated assemblies.
- .2 Approved fire stopping and smoke seal material in all fire separations and fire ratings within annular space between pipes, ducts, insulation and adjacent fire separation and/or fire rating.
- .3 Do not use cementitious or rigid seals around penetrations for pipe or other fire protection items piercing walls, floors, etc.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barrier at fire separation.
- .5 Provide materials and systems capable of maintaining effective barrier against flame, smoke and gases. Ensure continuity and integrity of fire separation.
- .6 Comply with the requirements of CAN4-S115-M35, and do not exceed opening sized for which they have been tested.
- .7 Systems to have an F or FT rating (as applicable) not less than the fire protection rating required for closures in a fire separation. Provide “fire wrap” blanket around services penetrating fire walls. Extent of blanket must correspond to ULC recommendations.
- .8 The fire stopping materials are not to shrink, slump or sag and to be free of asbestos, halogens and volatile solvents.
- .9 Firestopping materials are to consist of a component sealant applied with a conventional caulking gun and trowel.
- .10 Fire stop materials are to be capable of receiving finish materials in those areas which are exposed and scheduled to receive finishes. Exposed surfaces are to be acceptable to consultant prior to application of finish.
- .11 Firestopping shall be inspected and approved by local authority prior to concealment or enclosure.
- .12 Install material and components in accordance with ULC certification, manufacturers instructions and local authority.
- .13 Submit product literature and installation material on fire stopping in shop drawing and product data manual. Maintain copies of these on site for viewing by installers and consultant.
- .14 Manufacturer of product shall provide certification of installation. Submit letter to the consultant.

- .15 Acceptable Alternate Manufacturers to approval of local authority:
  - .1 Minnesota Mining and Manufacturing
  - .2 Fryesleeve Industries Inc.
  - .3 General Electric Pensil Firestop Systems
  - .4 International Protective Coatings Corp.
  - .5 Rectorseal Corporation (Metacaulk)
  - .6 Proset Systems
  - .7 3M
  - .8 AD Systems
  - .9 Hilti
- .16 Ensure firestop manufacturer representative performs onsite inspections and certifies installation. Submit inspection reports/certification at time of substantial completion.

**1.28 ESCUTCHEONS**

- .1 On pipes and ductwork passing through walls, partitions, floors and ceilings in exposed finished areas and on water and drain pipes inside millwork and cabinets.
- .2 Chrome or nickel plated brass or Type 302 stainless steel, one piece type with set screws.
- .3 Outside diameter to cover opening or sleeve.
- .4 Inside diameter to fit around finished pipe.

**1.29 PAINTING**

- .1 Refer to Section Interior Painting and specified elsewhere.
- .2 Apply at least one coat of corrosion resistant primer paint to ferrous supports and site fabricated work.
- .3 Apply two coats of paint to exposed piping service in mechanical room, electrical, and service rooms. Base colour shall be red.
- .4 Prime and touch up marred finished paintwork to match original.
- .5 Restore to new condition, or replace equipment at discretion of consultant, finishes which have been damaged too extensively to be merely primed and touched up.

**1.30 ACCESS DOORS**

- .1 Provide access doors to concealed fire protection equipment for operating, inspecting, adjusting and servicing.
- .2 Flush mounted 600 x 600 mm (24" x 24") for body entry and 300 x 300 mm (12" x 12") for hand entry unless otherwise noted. Doors to open 180°, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps.

- .3 Material:
  - .1 Special areas such as tiled or marble surfaces: use stainless steel with brushed satin or polished finish as directed by Consultant.
  - .2 Remaining areas: use prime coated steel.
  - .3 Fire rated areas: provide ULC listed access doors.
  - .4 Washrooms or high moisture area ceilings: Aluminum with mill finish suitable for painting.
- .4 Installation:
  - .1 Locate so that concealed items are accessible.
  - .2 Locate so that hand or body entry (as applicable) is achieved.
- .5 Acceptable materials:
  - .1 Le Hage
  - .2 Zurn
  - .3 Acudor
  - .4 Nailor Industries Inc.

#### **1.31 REPAIRS, CUTTING, AND RESTORATION**

- .1 Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
- .2 Each Section of this Division shall bear expense of cutting, patching, and repairing to install their work and/or replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.
- .3 Cutting, patching, repairing, and replacing pavements, sidewalks, roads, and curbs to permit installation of work of this Division is responsibility of Section installing work.
- .4 All patching, painting and making good of the existing walls, floors, ceilings, partitions and roof will be at the expense of this Contractor, but performed by the Contractor specializing in the type of work involved unless otherwise noted.

#### **1.32 EXISTING SYSTEMS**

- .1 Connections into existing systems to be made at time approved by Consultant. Request written approval of time when connections can be made.
- .2 Be responsible for damage to existing plant by this work.

#### **1.33 CLEANING**

- .1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units prior to turn over to owner.
- .2 In preparation for final acceptance, clean and refurbish all equipment and leave in operating condition including replacement of all filters in all air and piping systems.

---

**1.34 DISCONNECTION AND REMOVAL**

- .1 Disconnect and/or remove equipment, piping, etc. as indicated.
- .2 Cap and conceal all redundant and obsolete connections.

**1.35 EXISTING CONCRETE SLAB X-RAY/SCANNING**

- .1 This contractor shall retain the services of a qualified company to provide and X-ray and/or scan of the existing buried services in wall and/or floors prior to starting any work in the affected area.
- .2 Failure to locate existing piping, conduit rebar etc. shall not relieve this contractor of repair of same prior to installing his service.
- .3 This contractor shall be responsible for all repairs and/or replacement of existing services caused by cutting the existing concrete slabs and/or walls.

**1.36 INTEGRATED LIFE SAFETY SYSTEMS TESTING**

- .1 Fire protection systems in this building, including but not limited to flow switches, valves, fire pumps, etc. will be subject to Integrated Life Safety Systems testing.
- .2 The Fire Protection Contractor shall co-ordinate with the Integrated Life Safety Systems Testing Agent as follows:
  - .1 Confirm which fire protection systems are to be included as part of the testing process.
  - .2 Verify in writing to the Integrated Life Safety Systems Testing Agent that fire protection commissioning of the affected systems/devices is complete prior to the scheduled testing date(s).
  - .3 Participate in the Integrated Life Safety Systems Testing to confirm proper operation of all associated systems.
  - .4 This contractor shall work with the Integrated Life Safety Systems Testing Agent to reset all systems back to normal operating mode after the testing is complete.
- .3 Include all costs associated with Integrated Life Safety System Testing in the tender value.
- .4 Refer to Division 1/Division 26 Integrated Life Safety Systems Testing specifications for additional information/requirements.

**1.37 IDENTIFICATION OF SYSTEMS**

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.

- .2 Background colour marking and legends for piping systems:

<b>CONTENTS</b>	<b>BACKGROUND COLOUR</b>	
	<b>MARKING</b>	<b>LEGEND</b>
Fire protection water	Red	FIRE PROT. WTR
Sprinklers	Red	SPRINKLERS

### 1.38 FUNCTIONAL PERFORMANCE TESTS

- .1 This Contractor shall be responsible for the Functional Performance Tests. These tests ensure that all equipment and systems operate in accordance with design intent. Test the systems through all possible modes of operation.
- .2 The function performance test shall be:
- .1 Test piping systems.
  - .2 Test all valves and flow switches.
  - .3 Test flow and record flow from end of inspector's test port.
  - .4 Test flow from all standpipe systems at the most remote and highest hose connection.
  - .5 Test flow thru all backflow preventors.
  - .6 Test flow thru all fire pumps.
  - .7 Other test that maybe a requirement of NFPA.
- .3 All test shall be recorded and presented to the consultant and owner.
- .4 Include all test results in the Operation and Maintenance Manuals.

**END OF SECTION**



**Part 1 General**

**1.1 APPLICATION**

- .1 Seismic restraint is becoming more prominent with improved soil testing equipment. Seismic requirement is not site specific by geographical area but determined by site soil conditions.
- .2 Where the structural engineer or architect documents have  $I_e \cdot S_a(0.2) \cdot F_a < 3.5$  seismic is not required on the fire protection, mechanical, electrical, or plumbing systems.
- .3 Where the structural engineer or architect documents have  $I_e \cdot S_a(0.2) \cdot F_a \geq 3.5$  seismic is required on the fire protection, mechanical, electrical, or plumbing systems.
- .4 Seismic will always be required on fire protection systems when required by NFPA codes.
- .5 Seismic will always be required on any "Disaster Relief Building." For example, hospitals, police stations, ambulance building, etc.
- .6 When it is unclear in the tender documents request information from the structural engineer or architect for clarification.

**1.2 SECTION INCLUDES**

- .1 Seismic Requirements for single rod hanger support for conduit, pipe and other similar systems.
- .2 Seismic Requirements for trapeze type supports for cable tray, conduit, pipe and other similar systems.
- .3 Seismic requirements for all equipment and piping.

**1.3 RELATED WORK SPECIFIED ELSEWHERE**

- .1 Vibration Isolation Measures.

**1.4 REFERENCE STANDARDS**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 National Building Code of Canada (NBC).
- .3 Canadian Standards Association
  - .1 CSA S832, Seismic Risk Reduction of Operation and Functional Components (OFCs) of Buildings.
  - .2 CAN/CSA-S16.1 Limit States Design of Steel Structures
  - .3 CAN3-S136 Design of Cold Steel Structural Members
  - .4 CSA W47.1 Certification of Companies for Fusion Welding of Steel
  - .5 CSA W59 Welded Steel Construction
- .4 Canadian Institute of Steel Construction
- .5 Canadian General Standards Board

- .6 Underwriter Laboratories of Canada
- .7 Workers Compensation Board of BC
- .8 American Society of Testing and Materials
  - .1 ASTM A653/S653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (galvannealed) by the Hot Dip Process.
  - .2 ASTM A879M Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface.
  - .3 ASTM A307 Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .4 ASTM A325M Specification for Structural Bolts, Heat Treated 830MPa Minimum Tensile Strength.
- .9 All local codes.
- .10 NFPA-13: Installation of Fire Sprinkler Systems.
- .11 FEMA: Federal Emergency Management Activity.
- .12 FEMA: Seismic Restraint Installation Manuals 412. 413. & 414
  - .1 FEMA 412: Installing Seismic Restraints for Mechanical Equipment
  - .2 FEMA 413: Installing Seismic Restraints for Electrical Equipment
  - .3 FEMA 414: Installing Seismic Restraints for Duct and Pipe

## 1.5 DEFINITIONS

- .1  $A_v$ : Effective peak velocity related acceleration coefficient BOCA, SBC Code.
- .2  $S_1$ : Mapped Long Period Seismic Acceleration Coefficient IBC, TI-809-04, ASCE7.
- .3  $S_s$ : Mapped Short Period Seismic Acceleration Coefficient IBC, TI-809-04, ASCE7.
- .4  $v$ : Zonal Velocity Coefficient NBC-Canada.
- .5 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 VISCMA 102-2007: Static Qualification Standards for Obtaining a VISCMA Compliant Seismic Component Rating.
- .7  $Z$ : Seismic Zone defines Seismic Coefficient  $C_a$  used by UBC Code.

## 1.6 PERFORMANCE REQUIREMENTS

- .1 Design Ground Acceleration Coefficient ( $A_v$ ,  $S_s$ ,  $v$ , or  $Z$  depending on Code = X.XX).
- .2 (If IBC or TI-809-04) Design Long Period Ground Acceleration Coefficient ( $S_1$  = X.XX).
- .3 Design Soil Type = ( $S_a$ ,  $S_b$ ,  $S_c$ ,  $S_d$ ) as appropriate. (If NBC Canada, the Foundation Factor).
- .4 Importance or Performance Factor appropriate to structure =  $I_p$  = X.XX.

- .5 Schedule or drawings indicating critical ( $I_p = 1.5$ ) Duct/Piping systems, including systems whose importance factor may be increased by proximity to critical components.

## **1.7 DESCRIPTION OF SYSTEM**

- .1 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 fire protection 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.
- .2 The work under this section shall include furnishing all labour, materials, tools, appliances, and equipment, and performing all operations necessary for the complete execution of the installation of seismic snubber restraint assemblies as shown, detailed, and/or scheduled on the drawing and/or specified in this section of the specifications.
- .3 All seismic snubber restraint assemblies shall meet the following minimum requirements:
  - .1 The snubber/restrained isolator for isolated equipment shall include a resilient element that will ensure that no un-cushioned shock can occur (this does not include cable restraints).
  - .2 It shall be possible to visually inspect the resilient material for damage and allow for replacement, if necessary.
  - .3 All snubbers are to include a maximum air gap of 0.25 in (6 mm).
  - .4 Seismic restraint systems shall be designed to offer seismic restraint in all directions, unless otherwise noted.
  - .5 Seismic restraint capacities to be verified by an independent test laboratory or certified by a registered Professional Engineer to ensure that the design intent of this specification is realized. Verification shall be by one of the following methods:
    - .1 An NRTL (National Recognized Testing Laboratory), or laboratory recommended by VISCMA.
    - .2 Certified by a Professional Engineer with at least 5 years of experience, using industry standard methods of analysis, which employ common engineering practices. Adherence to the ratings standard within ASHRAE SPC171 and VISCMA 102-2007 is required.
    - .3 By a nationally recognized agency, such as VISCMA, that has reviewed and approved the restraint.

## **1.8 SYSTEM DESIGN**

- .1 Seismic restraint manufacturer shall be responsible for the structural design of 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 furnish, to the seismic restraint manufacturer, 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 furnished 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, ductwork and equipment is to be restrained to meet code requirements. At a minimum, the seismic restraint manufacturer 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 of the housekeeping pad is to be coordinated with the seismic restraint manufacturer to ensure that adequate edge distances exist in order to obtain the desired equipment anchor capacities.

#### **1.9 SEISMIC BRACING AND SUPPORT DESIGN REQUIREMENTS**

- .1 Seismic restraint designer shall co-ordinate all attachments with the structural engineer of record.
- .2 Design analysis shall include calculated dead loads, static seismic loads, and capacity of materials utilized for the connection of the equipment or system to the structure.
- .3 Analysis shall detail anchoring methods, bolt diameter, and embedment depth.
- .4 All seismic restraint devices shall be designed to accept without failure the forces calculated per the applicable building code and as summarized in Section 3.01.
- .5 Friction from gravity loads shall not be considered resistance to seismic forces.
- .6 Fire protection systems shall meet the requirements of NFPA-13 and NFPA-14. Sway bracing used for seismic restraint purposes must be fitted with provisions to resist the vertical force component of the diagonal brace. Single diagonal brace for seismic restraint will not be approved.

#### **1.10 QUALITY ASSURANCE**

- .1 The contractor shall provide pre-engineered seismic restraint systems to meet total design lateral force requirements for support and restraint of piping, conduit, cable trays and other similar systems and equipment where required by the applicable building code.
- .2 System Supports/Restraints: Firms regularly engaged in the manufacture of products of the types specified in this section, whose products have been in satisfactory use in similar service for not less than 5 years.
- .3 Bolted framing channels and fittings shall have the manufacturers name, part number, and material heat code identification number stamped in the part itself for identification. Material certification sheets and test reports must be made available by the manufacturer upon request.

- .4 Only companies experienced in performing the work of this section shall do the installation.
- .5 All seismic restraint installations shall be independently reviewed by the Owners Representative for compliance with project specifications.

#### **1.11 SUBMITTALS**

- .1 Product Data: Include Seismic Rating Curve for each seismically rated isolator or restraint component.
- .2 Samples: The contractor shall submit samples of specified seismic snubber devices for approval.
- .3 Shop Drawings shall include the following:
  - .1 Design Calculations: Calculate requirements for selecting seismically rated vibration isolators and seismic restraints. Certification documents to be signed and sealed by a qualified Professional Engineer with at least 5 years of experience in the design of seismic restraints. Professional engineer shall have local jurisdiction and provide periodic field review and final certification upon completion of the project. All costs and fees associated with the engineering shall be the responsibility of this contractor.
  - .2 Vibration Isolation Bases: Dimensional drawings including anchorage and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads.
  - .3 Seismic-Restraint Details: Detailed submittal drawings of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors. Include ratings for loads.
  - .4 Equipment Manufacturer Seismic Qualification Certification: The Equipment Manufacturer must submit certification that each piece of provided equipment will withstand seismic forces identified in "Performance Requirements" Article above. Include the following:
    - .1 Basis for Certification: Indicate whether the "withstand" certification is based on actual test assembled components or on calculations.
    - .2 Indicate the equipment is certified to be durable enough to:
      - .1 structurally resist the design forces and/or
      - .2 will remain functional after the seismic event.
  - .5 Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - .6 Detailed description of the assumed equipment anchorage devices on which the certification is based.

#### **1.12 DELIVERY, STORAGE, AND HANDLING**

- .1 Deliver strut systems, pipe hangers and components carefully to avoid breakage, denting, and scoring finishes. Do not install damaged equipment.
- .2 Store strut systems, pipe hangers and components in original cartons and in clean dry space; protect from weather and construction traffic.

**1.13 WORK FURNISHED BUT NOT INSTALLED**

- .1 The materials and systems specified in this section shall be purchased by the fire protection contractor from a single seismic snubber restraint materials manufacturer to assure sole source responsibility for the performance of the seismic restraints used.
- .2 The materials and systems specified in this section can, at the contractor's option, be installed by the subcontractor who installs the seismic restraint systems.

**1.14 COORDINATION**

- .1 Coordinate size, shape, reinforcement and attachment of all housekeeping pads supporting seismically rated equipment. Concrete shall have a minimum compressive strength of 3,000 psi or as specified by the consultant.
- .2 Coordinate with seismic restraint manufacturer to locate and size structural supports underneath seismically restrained equipment (e.g. roof curbs, cooling towers, and other similar equipment).

**1.15 INSTALLATION**

- .1 Installation of all seismic restraint materials specified herein shall be accomplished following the manufacturer's written instructions. Installation instructions shall be submitted to the engineer for approval prior to the beginning of the work.

**Part 2 Products**

**2.1 MATERIALS**

- .1 To the requirements of NFPA.

**Part 3 Execution**

**3.1 GENERAL INSTALLATION**

- .1 Installation of all seismic restraint materials specified in this section shall be accomplished as per the manufacturer's written instructions.
- .2 Refer to FEMA Manuals 412, 413, and 414 for typical industry standard installation guidelines.
- .3 Upon completion of installation of all seismic restraint materials and before start-up of restrained equipment, all debris shall be cleaned from beneath all protected equipment, leaving equipment free to contact snubbers/restraints.
- .4 Torque anchor bolts according to anchor manufacturer's written instructions to resist seismic forces.
- .5 All seismic restraint systems shall be installed in strict accordance with the manufacturer's seismic restraint guidelines manual and all certified submittal data.
- .6 Prior to installation, bring to the architect's/engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.

- .7 Brace support rods when necessary to accept compressive loads. Welding of compressive braces to the vertical support rods is not acceptable.
- .8 Seismic restraints shall be mechanically attached to the structural system. Looping restraints around the system is not acceptable.
- .9 Do not brace a system to two independent structures such as ceiling and wall.
- .10 Provide appropriately sized openings in walls, floors, and ceilings for anticipated seismic movement. Provide fire seal systems in fire-rated walls.
- .11 Seismic restraint cables shall be adjusted such that they are not visibly slack, or the flexibility is approximately 25mm under thumb pressure for a 1500mm cable length (equivalent ratio for other cable lengths).
- .12 All seismic restraint cables shall be at least 25mm clear of all other equipment and services.

### **3.2 FIRE PROTECTION PIPING**

- .1 Fire protection, sprinkler piping, and related equipment is considered as “Life Safety Equipment” and is to be seismically restrained per guidelines as published by NFPA (National Fire Protection Association).

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 NFPA 13 latest edition, Installation of Sprinkler Systems.
- .3 Ontario Fire Code.
- .4 Ontario Building Code.
- .5 Factory Mutual guidelines.

**1.2            SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with general requirements in accordance with NFPA 13, working plans and design requirements.
- .2 Shop drawings shall be approved by authority having jurisdiction prior to submission
- .3 Submit to consultant for general review and information only.
- .4 Submitted drawings shall be reproducible. Do not submit marked up prints.
- .5 Drawings shall be in AutoCad format.

**1.3            SAMPLES**

- .1 Submit samples in accordance with general requirements.
- .2 Submit samples of following:
  - .1 Each type of sprinkler head.
  - .2 Signs.

**1.4            ENGINEERING DESIGN CRITERIA**

- .1 Design system in accordance with Ontario Fire Marshall, local authority having jurisdiction, owner's underwriters as required, and NFPA 13, NFPA 20, and NFPA 45 using following parameters:
  - .1 To suit occupancy as indicated.
  - .2 Pipe size and layout: Hydraulic design.
  - .3 Conduct flow and pressure test of water supply in vicinity of project to obtain criteria for bases of design in accordance with NFPA 13. Indicate location and flow on shop drawings.
  - .4 System zoning as indicated in accordance with NFPA 13.
  - .5 Provide complete drawings and calculations stamped by a qualified professional engineer registered in the Province of Ontario.
  - .6 Professional Engineer shall provide on site review and certification for local building code review.



- .2 System shall be approved by Ontario Fire Marshall, local authority, and owner's underwriter prior to shop drawing submission.

#### **1.5 COMMISSIONING & INTEGRATED TESTING OF FIRE PROTECTION & LIFE SAFETY SYSTEMS**

- .1 Sprinkler contractor to perform services with the Fire Commissioning Agent (FCA) to meet their requirements for administration, verification, and final sign-off.
- .2 The Fire Commissioning Agent (FCA) is being retained by the electrical contractor, however; this contractor's work to satisfy the FCA requirements shall be included in the tender price.
- .3 The sprinkler contractor at a minimum must include for:
  - .1 Providing FCA all documentation of design and shop drawings.
  - .2 Provide documents for sequence of operation and maintenance of system.
  - .3 Movement of all valves and accessories to confirm Alarm/Supervisory/Trouble at the fire panel.
  - .4 Create flow at all initiating devices to verify detection at the fire panel.
  - .5 Testing and operation of any fire pumps.
  - .6 Other items that may be requested by the FCA.
  - .7 Re-commissioning of any items that may have failed.
  - .8 Putting the system back into proper operation after tests are completed.
- .4 All work to be performed in accordance with NFPA 3 2010 Edition. Special consideration to be given to Figure A3.3.16 (b) for Sequence of Operation Form required to be completed in conjunction with the FCA and submitted to the consultant's prior to occupancy.
- .5 The work to be performed by this contractor is also described in NFPA 3 table A.5.1.1 as labelled "Construction Stage" and "Occupancy Stage".

#### **1.6 MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.

#### **1.7 MAINTENANCE MATERIALS**

- .1 Provide maintenance materials in accordance with general requirements.
- .2 Provide spare sprinklers and tools as required by NFPA 13.

#### **1.8 QUALIFICATIONS**

- .1 Contractor to be specialist in performing work of this section, and have **at least 3 years** successful experience in this size and type of project.

#### **1.9 PERMITS AND FEES**

- .1 Obtain and pay for all permits, fees, and inspections as required by authority having jurisdiction.

**1.10 EQUIPMENT**

- .1 ULC listed and labeled.

**1.11 STORAGE**

- .1 Store in original packaging with manufacturers' labels and seals intact.
- .2 Store in dry secure location.
- .3 Damaged material and/or equipment shall be replaced.

**Part 2 Products**

**2.1 PIPE, FITTINGS, AND VALVES**

- .1 Pipe and Fittings:
  - .1 25 mm (1"): Schedule 40 steel pipe with screwed fittings.
  - .2 32 mm (1¼") to 50 mm (2"):
    - .1 Schedule 40 steel pipe with screwed fittings or,
    - .2 Schedule 10 steel pipe with roll grooved fittings.
  - .3 65 mm (2½") and larger: Schedule 10 steel pipe with roll grooved fittings.
- .2 Valves:
  - .1 ULC listed for fire protection service.
  - .2 Up to NPS 2: bronze, screwed ends, OS&Y gate.
  - .3 NPS 2 1/2 and over: cast iron, flanged or roll grooved ends, indicating butterfly valve.
  - .4 Swing check valves.
  - .5 Ball drip.
- .3 Pipe hangers:
  - .1 ULC listed for fire protection services.
- .4 End switches:
  - .1 Provide on all isolating valves.
  - .2 Coordinate voltage and location with fire alarm contractor.
- .5 Flow switches:
  - .1 Provide where indicated and required.
  - .2 Coordinate voltage and location with fire alarm contractor.

**2.2 SPRINKLER HEADS**

- .1 General: to NFPA 13 and ULC listed for fire services.
- .2 Indicate type and location of sprinkler heads on drawings. Co-ordinate sprinkler heads location with other trades.

- .3 Locate sprinkler heads in acoustic tile ceiling in centre of tile.
- .4 Provide sprinkler heads as follows:
  - .1 Upright bronze: exposed with no ceilings.
  - .2 Concealed fusible link type brass pendent with ring and cup in ceiling and brass coverplate. Coverplate finish selected by consultant. Concealed heads installed in unsupervised areas (corridors, washrooms).
  - .3 White semi-recessed fusible link type brass pendent with adjustable, recessed escutcheon ring and cup. Sprinkler and escutcheon cup. Finish selected by consultant. Semi-recessed heads installed in supervised areas (classrooms, offices, seminar rooms etc.).
  - .4 Sprinkler heads with O-ring design shall not be used.
  - .5 Provide guards on upright sprinkler heads in all storage rooms, in the gymnasium and on heads below 1800 mm AFF.
- .5 Provide sprinkler heads under all equipment/ductwork over 1200 mm wide.

## **2.3 WET PIPE ALARM CHECK VALVE**

- .1 Alarm check valve to NFPA 13 and ULC listed for fire service.
- .2 Cast iron body, stainless steel fitted with EPDM seal on bronze seated ring, flanged connections.
- .3 (Constant pressure) (**variable** pressure with closed retard drain) Trim kit, pressure relief kit and high and low pressure alarm switches, pressure gauges, 50mm drain valve and interior electric alarm, exterior gong, signage and fire alarm connection.
- .4 Electrical contractor will provide 120V/1/60 power source within 1500 mm of valve. All wiring shall be by this contractor.

## **2.4 SUPERVISORY SWITCHES**

- .1 General: to NFPA 13 and ULC listed for fire service.
- .2 Valves:
  - .1 Mechanically attached to valve body, with normally open and normally closed contacts and supervisory capability.
- .3 Flow switch type:
  - .1 With normally open and normally closed contacts and supervisory capability.
- .4 Pressure alarm switch:
  - .1 With normally open and normally closed contacts and supervisory capability.

## **2.5 PRESSURE GAUGES**

- .1 ULC listed
- .2 Shall have maximum limit of not less than twice normal working pressure at point where installed.

## **2.6 SIGNS**

- .1 Signs for control drain and test valves: to NFPA 13.
- .2 Provide exterior signage for Fire Department connection. Location of signage and text shall be to the approval of the local authority having jurisdiction.

## **2.7 SPARE PARTS CABINET**

- .1 For storage of maintenance materials, spare sprinkler heads and special tools.
- .2 Include all types and temperature ratings of sprinkler heads installed.
- .3 Construct to sprinkler head manufacturers standard.
- .4 Install where directed on site or next to alarm valve.

## **2.8 INSPECTORS TEST CONNECTIONS**

- .1 Provide where indicated and to requirements of local authority.
- .2 Discharge to building exterior to acceptance of consultant.
- .3 Provide suitable signage to satisfaction of authority having jurisdiction and consultant.

## **2.9 DOCUMENTATION**

- .1 Prepare documentation as indicated.
- .2 Provide documentation based on tender documents. Coordinate sprinkler drawings with all trades.
- .3 Provide one hard copy and one electronic copy of As Built drawings acceptable to consultant prior to final payment.

## **2.10 UNIT PRICES**

- .1 Provide unit prices as follows.
  - .1 Additional sprinkler head including hangers, 3.6 M piping and two elbows.
  - .2 Delete sprinkler head including hangers, 3.6 M piping and two elbows.

## **2.11 UNDERWRITERS APPROVED GATE VALVE**

- .1 NPS 65 – 350 mm (2 1/2" - 14"), OS&Y:
  - .1 Approvals: UL and FM approved for fire service.
  - .2 UL and FM Label: on valve yoke.
  - .3 Body, Bonnet: cast iron to ASTM A 126 Class B. Wall thicknesses to ANSI B 16.1 and ULC 262(B).
  - .4 Bonnet bushing, yoke sleeve: bronze, to FM requirements.
  - .5 Packing gland: bronze.
  - .6 Stem: manganese bronze. Diameter to ULC C-262(B).
  - .7 Stuffing box dimensions, gland bolt diameter: to ULC C 262(B).
  - .8 Bosses for bypass valve, drain: on NPS 100 mm (4") and over.

- .9 Disc: solid taper wedge. Up to NPS 80 mm (3"): bronze. NPS 100 mm (4") and over: cast iron with bronze disc rings.
- .10 Disc seat ring: self-aligning, Milwood undercut on NPS 80 mm (3").
- .11 Pressure rating:
  - .1 NPS 65 – 300 mm (2-1/2" - 12"): 1.7 MPa (250 psi) CWP
  - .2 NPS 350 mm (14"): 1.2 MPa (175 psi) CWP
- .12 Operator: Handwheel.

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 Install, inspect and test to acceptance in accordance with NFPA 13 and FC 403.
- .2 Install excess pressure pump across alarm valve in accordance with manufacturer's instructions.
- .3 Pipe a bypass complete with indicating valve, between Fire department connection and sprinkler main downstream of DCVA. Bypass shall be sized to allow flow test of system demand as per NFPA 13 forward flow test thru the backflow preventor.
- .4 Testing to be witnessed by authority having jurisdiction.
- .5 Space hangers and support of sprinkler piping in accordance with N.F.P.A. regulations.
- .6 Hydrostatically test systems at 350kPa in excess of normal working pressure, but not less than 1.4 MPA for two hours without loss under supervision of authority having jurisdiction and NFPA requirements.
- .7 Provide hydraulic pump, temporary connections and labour required for tests.
- .8 Protect exposed work, in accordance with 'Painting' section.
- .9 Do not cover or conceal piping accessories or work prior to inspection and approval by authorities having jurisdiction.
- .10 Adjust equipment to satisfaction of authority having jurisdiction and consultant.
- .11 Protect equipment during painting. Replace damaged and painted components.
- .12 Co-ordinate the sprinkler piping and equipment with that of other trades on the job. Mains and branches shall be run so as not to interfere with building's structure, mechanical, or electrical installations. Branch piping above ceilings is to run in joist space or minimum 300 mm above ceiling. Provide drops at head locations only. All exposed piping to run in joist space.
- .13 Guarantee that the systems and equipment be installed in accordance with all Local and Provincial by-laws and the rules and regulations of the Insurance Underwriters and the Building Code of Ontario.
- .14 Provide a flow test for each system on the remote inspectors test connection using methods approved by the local fire department and local water commission. Report the test results in writing to the consultant.

**3.2 WATER FLOW TEST**

- .1 Provide a flow test to approval of local fire department and local water commission at nearest fire hydrant adjacent to building to determine water flow rate and pressure. Provide written test results with shop drawing submission.
- .2 Provide a forward flow test thru the bypass to prove system demand can be provided thru the backflow preventer.

**END OF SECTION**

**Part 1            General**

**1.1            GENERAL PROVISIONS**

- .1      This section covers items common to all sections of Plumbing Division.
- .2      Conform to Division 1 General Conditions.
- .3      Furnish labour, materials, and equipment necessary for completion of work as described in contract documents.
- .4      Unless specifically indicated, all materials and equipment provided under this contract shall be new and shall be manufactured in the project year.
- .5      The term “Mechanical Contractor” shall remain active and shall mean a “single contractor” performing plumbing, drainage, heating, cooling, ventilation, and control services.
- .6      When quoting as a subcontractor this contractor shall explicitly state the services they are providing i.e. Mechanical (all services), Plumbing (water and drainage systems) or HVAC (including hydronic and air systems).
- .7      Contractors shall be explicit to identify whether Fire Protection is included or omitted from the mechanical scope.

**1.2            INTENT**

- .1      Mention herein or indication on Drawings of articles, materials, operations or methods requires: supply of each item mentioned or indicated, of quality, or subject to qualifications noted; installation according to conditions stated: and, performance of each operation prescribed with furnishing of necessary labour, equipment, and incidentals for plumbing work.
- .2      Where used, words “Section” and “Division” shall also include other Subcontractors engaged on site to perform work to make building and site complete in all respects.
- .3      Where used, word “supply” shall mean furnishing to site in location required or directed complete with accessory parts.
- .4      Where used, word “install” shall mean secured in place and connected up for operation as noted or directed.
- .5      Where used, word “provide” shall mean supply and install as each is described above.

**1.3            REGULATIONS, PERMITS, AND FEES**

- .1      All materials and quality of work shall meet all current and latest Provincial, Municipal and Fire Marshall requirements, regulations, codes, and by-laws in force in the area of the project.
- .2      Each contractor shall give all necessary notices, obtain all necessary permits, and pay all fees in order that the work shown or specified may be carried out. Each contractor shall furnish any certificates necessary as evidence that the work installed conforms with the laws and regulations of all authorities having jurisdiction.

- .3 In the event that changes, or alterations are required on completed work by authorized inspectors, these changes shall be made at the contractor's expense.
- .4 Special equipment which does not have a standard CSA label shall be inspected by the local electrical authority having jurisdiction and the Approval Certificate shall be submitted to the Consultant as soon as possible. All costs and fees for inspections shall be borne by this contractor.

#### **1.4 DRAWINGS**

- .1 The drawings and this specification have been assembled together as a responsibility of the consultant. The same is true for the other consultants, i.e. architect, structural engineer, civil engineer, fire protection engineer, electrical engineer, etc.
- .2 The drawings and specifications are not assembled together for responsibility/division between subcontractors. The division of work between subcontractors remains the responsibility of the buildings' contractor (also known as the prime contractor or general contractor).
- .3 All subcontractors are encouraged to perform work amicably utilizing all of the drawings and specifications published by all of the consultants.
- .4 Plumbing and Mechanical Drawings do not show structural and related details. Take information involving accurate measurement of building from building drawings, or at building. Make, without additional charge, any necessary changes, or additions to runs of piping, conduits, and ducts to accommodate structural conditions. Location of pipes, ducts, conduits and other equipment may be altered by Consultant without extra charge provided change is made before installation and does not necessitate major additional material.
- .5 As work progresses and before installing piping, ductwork, heating units, registers, diffusers, fixtures and any other fittings and equipment which may interfere with interior treatment and use of building, provide detail drawings, or obtain directions for exact location of such equipment and fittings.
- .6 Plumbing and Mechanical Drawings indicate general location and route of pipes, ducts and conduits which are to be installed. Where required work is not shown or only shown diagrammatically, install same at maximum height in space to conserve head room (minimum 2200 mm (88") clear) and interfere as little as possible with free use of space through which they can pass. Follow building lines, conceal piping, conduits and ducts in furred spaces, ceilings and walls unless specifically shown otherwise. Install work close to structure so furring will be small as practical.
- .7 Install piping and ductwork to clear structural members and any fireproofing. Locate plumbing work to permit installation of specified insulation. Do not remove or damage structural fireproofing. Leave space to permit fireproofing and insulation to be inspected and repaired.
- .8 Before commencing work, check and verify all sizes, locations, grade and invert elevations, levels, and dimensions to ensure proper and correct installation. Verify existing/municipal services.
- .9 Locate all plumbing, mechanical, and electrical equipment in such a manner as to facilitate easy and safe access to and maintenance and replacement of any part.



- .10 In every place where there is indicated space reserved for future or other equipment, leave such space clear, and install piping and other work so that necessary installation and connections can be made for any such apparatus. Obtain instructions whenever necessary for this purpose.
- .11 Relocate equipment and/or material installed but not co-ordinated with work of other Sections and/or installed incorrectly as directed, without extra charge.
- .12 Where drawings are done in metric and product not available in metric, the corresponding imperial trade size shall be utilized.

#### **1.5 INTERFERENCE AND COORDINATION DRAWINGS**

- .1 Prepare interference and equipment placing drawings to ensure that all components will be properly accommodated within the constructed spaces provided.
- .2 Prepare drawings to indicate co-ordination and methods of installation of a system with other systems where their relationship is critical. Ensure that all details of equipment apparatus, and connections are coordinated.
- .3 Ensure that clearances required by jurisdictional authorities and clearances for proper maintenance are indicated on drawings.
- .4 Upon consultant's request submit copies of interference drawings to consultant.
- .5 Due to the nature of the building and the complexity of the building systems provide the following:
  - .1 Interference drawings, showing coordination of architectural, structural, plumbing, mechanical, and electrical systems for the consultant's review prior to fabrication.
  - .2 Detailed layout drawings, clearly showing fasteners and hangers.
- .6 Provide CAD drawings (minimum file version AutoCAD 2013) in addition to hard copies.

#### **1.6 QUALITY ASSURANCE**

- .1 Perform work in accordance with applicable provisions of local Plumbing Code, Gas Ordinances, and adoptions thereof for all plumbing systems. Provide materials and labor necessary to comply with rules, regulations, and ordinances.
- .2 In case of differences between building codes, provincial laws, local ordinances, utility company regulations, and Contract Documents, the most stringent shall govern. Promptly notify Consultant in writing of such differences.

#### **1.7 ALTERNATES AND SUBSTITUTIONS**

- .1 Throughout Plumbing and Mechanical Division are lists of "Alternate Equipment" manufacturers acceptable to Consultant if their product meets characteristics of specified described equipment. Submitted Bids shall be based on the supply of named articles and or products as specified in the RFT Documents.

- .2 Each bidder may elect to use “Alternate Equipment” from lists of Alternates where listed. Include for any additional costs including all costs for revisions to electrical contract to suit Alternate used.
- .3 When two or more suppliers/manufacturers are named in the Bid Documents, only one supplier/manufacturer of the products named will be acceptable; however, it is the responsibility of this Division to ensure “Alternate Equipment” fits space allocated and gives performance specified. If an “Alternate Equipment” nor “equal” specified product unit is proposed and does not fit space allotted in Consultant’s opinion, supply of specified described equipment will be required without change in Contract amount. Should electrical characteristics for “alternate” or “equal” equipment differ from equipment specified it shall be the responsibility of the equipment manufacturer to pay all costs associated with the revisions to the electrical contract. Only manufacturers listed will be accepted for their product listing. All other manufacturers shall be quoted as substitution stating conditions and credit amount.
- .4 If item of material specified is unobtainable, submit as a question during tender period.
- .5 If pipe or item, of size or weight indicated, is unobtainable, supply next larger size or heavier weight without additional charge.

## **1.8 EXAMINATION**

- .1 Site Reviews
  - .1 Examine premises to understand conditions, which may affect performance of work of this Division before submitting proposals for this work.
  - .2 No subsequent allowance for time or money will be considered for any consequence related to failure to examine site conditions.
- .2 Drawings:
  - .1 Plumbing and Mechanical Drawings show general arrangement of piping, ductwork, equipment, etc. Follow as closely as actual building construction and work of other trades will permit.
  - .2 Consider Architectural and Structural Drawings part of this work insofar as these drawings furnish information relating to design and construction of building. These drawings take precedence over Plumbing, Mechanical, and Fire Protection Drawings.
  - .3 Because of small scale of Drawings, it is not possible to indicate all offsets, fittings, and accessories, which may be required. Investigate structural and finish conditions affecting this work and arrange work accordingly, providing such fittings, valves, and accessories required to meet conditions.
- .3 Ensure that items to be furnished fit space available. Make necessary field measurements to ascertain space requirements including those for connections and furnish and install equipment of size and shape so final installation shall suit true intent and meaning of Contract Documents. If approval is received by Addendum or Change Order to use other than originally specified items, be responsible for specified capacities and for ensuring that items to be furnished will fit space available.

---

**1.9 SEQUENCING SCHEDULING AND COORDINATION**

- .1 It is understood that while Drawings are to be followed as closely as circumstances permit, this Division will be held responsible for installation of systems according to the true intent and meaning of Contract Documents. Anything not clear or in conflict will be explained by making application to Consultant. Should conditions arise where certain changes would be advisable, secure Consultant's approval of these changes before proceeding with work.
- .2 Coordinate work of various trades in installing interrelated work. Before installation of plumbing items, make proper provision to avoid interferences in a manner approved by Consultant. Each Contractor shall refer to all sections of the specification for their responsibilities with other trades. Changes required in work specified in Plumbing Division caused by neglect to do so shall be made at no cost to Owner.
- .3 Arrange pipes, ducts, and equipment to permit ready access to valves, unions, traps, starters, motors, control components, and to clear openings of doors and access panels.
- .4 Furnish and install inserts and supports required by Plumbing Division unless otherwise noted. Furnish sleeves, inserts, supports, and equipment that are an integral part of other Divisions of the Work to Sections involved in sufficient time to be built into construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne by Plumbing Division.
- .5 Be responsible for required excavation, backfilling, cutting, and patching incident to work of this Division and make required repairs afterwards to satisfaction of Consultant. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses.
  - .1 Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
  - .2 Each Section of this Division shall bear expense of cutting, patching, repairing, and replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.
  - .3 Cutting, patching, repairing, and replacing pavements, sidewalks, roads, and curbs to permit installation of work of this Division is responsibility of Section installing work.
- .6 Adjust locations of pipes, ducts, equipment, fixtures, etc, to accommodate work from interferences anticipated and encountered. Determine exact route and location of each pipe and duct prior to fabrication.
  - .1 Make offsets, transitions, and changes in direction of pipes, ducts, and electrical raceways as required to maintain proper head room and pitch of sloping lines whether or not indicated on Drawings.
  - .2 Furnish and install traps, air vents, sanitary vents, pull boxes, etc, as required to effect these offsets, transitions, and changes in direction.

- .7 Slots and openings through floors, walls, ceilings, and roofs shall be provided by this contractor but performed by a trade specializing in this type of work. This Division shall see that they are properly located and do any cutting and patching caused by its neglect to do so.

#### **1.10 REQUEST FOR INFORMATION (RFI) PROCEDURES**

- .1 RFIs shall be submitted to the consultant minimum two (2) weeks prior to answer being required. Failure to submit an RFI in a timely manner will forfeit delay claims and schedule extension requests by the contractor.
- .2 All RFIs will be submitted with the following information:
  - .1 RFI number
  - .2 Name of project
  - .3 Date of initiation
  - .4 Date response required by (minimum two (2) weeks)
  - .5 Subject
  - .6 Submitter's name
  - .7 Drawing/specification reference
  - .8 Photograph of the issue (if applicable)
  - .9 Description of the issue
  - .10 Contractor's proposed resolution

#### **1.11 CONTRACT BREAKDOWN**

- .1 Provide breakdown of contract exclusive of HST to acceptance of consultants prior to first draw submission.
- .2 Provide labour and material cost for each item.
- .3 Breakdown shall indicate total contract amount.
- .4 Contract breakdown shall be as follows as a minimum.
  - Mobilization and shop drawings
  - Demolition
  - Inside buried plumbing and drainage
  - Above grade rough-in plumbing and drainage
  - Roof drainage system
  - Plumbing Fixtures
  - Plumbing Equipment
  - Specialty Piping
  - Piping Insulation
  - Fire Stopping
- .5 Progress claims, when submitted are to be itemized against each item of the contract breakdown, this shall be done in table form showing contract amount, work complete to date, previous draw, amount this draw and balance.
- .6 **Mobilization amount may only be drawn when all required shop drawings have been reviewed by the consultant.**

---

**1.12 COMMISSIONING CONTRACT BREAKDOWN**

- .1 This contractor shall work with the plumbing and HVAC system commissioning contractor as specified elsewhere. The following commissioning breakdown shall be indicated on the contract breakdown draw.

**1.13 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Furnish complete catalog data for manufactured items of equipment to be used in the Work to Consultant for review within 14 days after award of Contract.
- .2 Upon receipt of reviewed shop drawing, product is to be ordered immediately.
- .3 Provide a complete list of shop drawings to be submitted prior to first submission.
- .4 Before submitting to the Consultant, review all shop drawings to verify that the products illustrated therein conform to the Contract Documents. By this review, the Contractor agrees that it has determined and verified all field dimensions, field construction criteria, materials, catalogue numbers, and similar data and that it has checked and coordinated each shop drawing with the requirements of the work and of the Contract Documents. The Contractor's review of each shop drawings shall be indicated by stamp, date and signature of a qualified and responsible person possessing by the appropriate authorization.
- .5 If material or equipment is not as specified or submittal is not complete, it will be rejected by Consultant.
- .6 Additional shop drawings required by the contractor for maintenance manuals, site copies etc., shall be photocopies of the "reviewed" shop drawings. All costs to provide additional copies of shop drawings shall be borne by the contractor.
- .7 **Submit all shop drawings for the project as a package. Partial submittals will not be accepted.**
- .8 Catalog data or shop drawings for equipment, which are noted as being reviewed by Consultant or their Engineer shall not supersede Contract Documents.
- .9 Review comments of Consultant shall not relieve this Division from responsibility for deviations from Contract Documents unless Consultant's attention has been called to such deviations in writing at time of submission, nor shall they relieve this Division from responsibility for errors in items submitted.
- .10 Check work described by catalog data with Contract Documents for deviations and errors.
- .11 Shop drawings and product data shall show:
  - .1 Mounting arrangements.
  - .2 Operating and maintenance clearances. e.g., access door swing spaces.
- .12 Shop drawings and product data shall be accompanied by:
  - .1 Detailed drawings of bases, supports, and anchor bolts.
  - .2 Acoustical sound power data, where applicable.
  - .3 Points of operation on performance curves.
  - .4 Manufacturer to certify as to current model production.

- .5 Certification of compliance to applicable codes.
- .13 State sizes, capacities, brand names, motor HP, accessories, materials, gauges, dimensions, and other pertinent information. List on catalog covers page numbers of submitted items. Underline applicable data.
- .14 Shop drawings shall be submitted electronically as per the following directions:
  - .1 Electronic Submissions:
    - .1 Electronically submitted shop drawings shall be prepared as follows:
      - .1 Use latest software to generate PDF files of submission sheets.
      - .2 Scanned legible PDF sheets are acceptable. Image files are not acceptable.
      - .3 PDF format shall be of sufficient resolution to clearly show the finest detail.
      - .4 PDF page size shall be standardized for printing to letter size (8.5"x11"), portrait with no additional formatting required by the consultant. Submissions requiring larger detail sheets shall not exceed 11"x17".
      - .5 Submissions shall contain multiple files according to section names as they appear in Specification.
      - .6 File names shall include consultant project number and description of shop drawing section submitted.
      - .7 Each submission shall contain an index sheet listing the products submitted, indexed in the same order as they appear in the Specification. Include associated PDF file name for each section.
      - .8 On the shop drawing use an "electronic mark" to indicate what is being provided.
      - .9 **Each file shall bear an electronic representation of the "company stamp" of the contractor. If not stamped the file submission will not be reviewed.**
    - .2 Email submissions shall include subject line to clearly identify the consultants project number and the description of the shop drawings submitted.
    - .3 Electronic attachments via email shall not exceed 10MB. For submissions larger than 10MB, multiple email messages shall be used. Denote related email messages by indicating "1 of 2" and "2 of 2" in email subject line for the case of two messages.
    - .4 Electronic attachments via web links (URL) shall directly reference PDF files. Provide necessary access credentials within link or as username/password clearly identified within body of email message.
    - .5 On site provide one copy of the "reviewed" shop drawings in a binder as noted above.

- .6 Contractor to print copies of “reviewed” shop drawings and compile into maintenance manuals in accordance with requirements detailed in this section.

#### **1.14 COMMISSIONING CONTRACT BREAKDOWN**

- .1 This contractor shall work with the plumbing and HVAC system commissioning contractor as specified elsewhere.

#### **1.15 EQUIPMENT NAMEPLATE DATA**

- .1 Between the manufactures design published literature, the shop drawing submission literature, and the nameplate data on the equipment, they can all read differently.
- .2 Most of the confusion and differences are coming out of the electrical power installation.
- .3 The contractors installing and connecting the equipment are responsible for the coordination of this data through the construction period.
- .4 The contractors shall share and/or request this information through out the project and monitor/make adjustments, provide recommendations accordingly based on any discrepancies.
- .5 The contractors are responsible for any cost associated with the changing data.
- .6 The final installation must meet the “Nameplate Data” on the equipment on site.

#### **1.16 OPERATION AND MAINTENANCE MANUAL**

- .1 Provide operation and maintenance data for incorporation into manual as in submittals’ requirements.
- .2 Operation and maintenance manual to be approved by, and final copies deposited with, Consultant before final inspection.
- .3 Submit 1 copy of Operation and Maintenance Manual to Consultant for approval. Submission of individual data will not be accepted unless so directed by Consultant. Submission can be done electronically in pdf format or as a hardcopy.
  - .1 Electronic submission/pdf file is required to be bookmarked. Any submission received without bookmarking will be immediately returned as unacceptable.
  - .2 Hardcopy submission shall be in a three-ring binder (minimum 50 mm (2") ring) and labelled as ‘Operation and Maintenance Manual’ with project name and location. Dividers are to be used for binder organization.
- .4 Make changes as required and re-submit as directed by Consultant.
- .5 Operation data to include:
  - .1 Control schematics for each system including environmental controls.
  - .2 Description of each system and its controls.
  - .3 Operation instruction for each system and each component.
  - .4 Description of actions to be taken in event of equipment failure.
  - .5 Valves schedule and flow diagram.

- .6 Colour coding chart.
- .7 Spare parts equipment list.
- .8 Manufacturers standard or extended warranty information.
- .6 Maintenance data shall include:
  - .1 Servicing, maintenance, operation, and trouble-shooting instructions for each item of equipment.
  - .2 Data to include schedules of tasks, frequency, tools required and task time.
- .7 Performance data to include:
  - .1 Equipment manufacturer's performance data sheets with point of operation as left after commissioning is complete.
  - .2 Equipment performance verification test results.
  - .3 Special performance data as specified elsewhere.
  - .4 Testing, adjusting and balancing reports as specified in Testing, Adjusting and Balancing Section.
  - .5 Copy of all substantial performance final certificates.
- .8 Miscellaneous data to include:
  - .1 Letter of contractor's warranty and guarantee.
  - .2 Index sheet.
  - .3 Tabbed format for each section.
  - .4 Manufacturers approved shop drawings.
  - .5 Spare parts list and source.
  - .6 List of Manufacturers and suppliers address for each piece of equipment.
- .9 Final Submittals:
  - .1 Upon acceptance of Operation and Maintenance Manual by the Consultant provide the following:
    - .1 Provide two (2) copies of final operation maintenance manuals, as well as a PDF file of the entire approved manual on a USB stick. Only one USB stick is to be provided containing both the approved manual and as-built drawings.

#### **1.17 AS-BUILT DRAWINGS**

- .1 Site records:
  - .1 Contractor shall provide 2 sets of reproducible plumbing drawings. Provide sets of white prints as required for each phase of the work. Mark thereon all changes as work progresses and as changes occur. This shall include changes to existing plumbing systems, control systems, and low voltage control wiring.
  - .2 On a weekly basis, transfer information to reproducibles, revising reproducibles to show all work as actually installed.
  - .3 Use different colour waterproof ink for each service.
  - .4 Make available for reference purposes and inspection at all times.



- .2 As-Built drawings:
  - .1 Prior to start of Testing, Adjusting and Balancing (TAB), finalize production of as-built drawings.
  - .2 Identify each drawing in lower right hand corner in letters at least 3 mm (1/8") high as follows: - "AS-BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW PLUMBING SYSTEMS AS INSTALLED" (Signature of Contractor) (date).
  - .3 TAB to be performed using as-built drawings.
    - .1 Submit hard copy to Consultant for approval. When returned, make corrections as directed.
    - .2 Once approved, submit completed reproducible paper as-built drawings as well as a scanned pdf file copy on USB stick with Operating and Maintenance Manuals.

#### **1.18 WARRANTIES**

- .1 In addition to guarantee specified in General Conditions, guarantee plumbing systems to be free from noise in operation that may develop from failure to construct system in accordance with Contract Documents.
- .2 Provide certificates of warranty for each piece of equipment made out in favor of Owner. Clearly record "start-up" date of each piece of equipment on certificate. Include certificates as part of Operation & Maintenance Manual.
- .3 If plumbing sub-contractor with offices located more than 80 km (50 miles) from Project site is used, provide service/warranty work agreement for warranty period with local plumbing sub-contractor approved by Consultant. Include copy of service/warranty agreement in warranty section of Operation & Maintenance Manual.
- .4 Warranty period shall start from date of ready for takeover.

#### **1.19 OCCUPANCY REQUIREMENTS**

- .1 The contractor shall provide the following documentation to the consultant's satisfaction prior to receiving occupancy. Failure to provide the proper documentation will result in the occupancy not being granted. List of required documentation:
  - .1 Final Certificates (required prior to consultant's release of conformance letter).
    - .1 Potable Water Test (Refer to domestic water piping – Copper section – Part 3)
    - .2 Backflow Test Certificate (for all testable devices)
    - .3 Seismic Restraint Engineers' Letter

#### **1.20 READY FOR TAKEOVER**

- .1 Complete the following to the satisfaction of the consultant prior to request for ready for takeover.
  - .1 As-Built Drawings.
  - .2 Maintenance Manuals
  - .3 System Start up

- .4 TAB Reports
- .5 HVAC System Commissioning
- .6 Instructions to Owners

**1.21 REVISION TO CONTRACT**

- .1 Provide the following:
  - .1 Itemized list of material with associated costs.
  - .2 Labour rate and itemized list of labour for each item.
  - .3 Copy of manufacturers/supplier's invoice if requested.

**1.22 DELIVERY, STORAGE, AND HANDLING**

- .1 Follow Manufacturer's directions in delivery, storage, and protection, of equipment and materials. Contractor to include all costs associated with delivery storage and handling in tender price.
- .2 Deliver equipment and material to site and tightly cover and protect against dirt, water, and chemical or environmental damages but have readily accessible for inspection. Store items subject to moisture damage (such as controls) in dry, heated space.
- .3 Remove all damaged materials from site.

**1.23 DESIGNATED SUBSTANCES AND HAZARDOUS MATERIALS**

- .1 **If designated substances and/or hazardous materials are suspected or identified cease all work in the immediate area in accordance with OHSA and notify consultant.**
- .2 **Each contractor and on site employee of the contractor shall have "asbestos awareness training".**
- .3 The Contractor shall ensure that employees who may come into contact with designated substances and/or hazardous materials due to the nature of the work that they perform, have received training that enables them to recognize designated substances and/or hazardous materials and that enables them to react in accordance with the Occupational Health and Safety Act and regulations thereto should contact with designated substances and/or hazardous materials occur during the course of their work.
- .4 **It is the responsibility of the contractor to review the designated substances and/or hazardous materials book in the building prior to starting any work.**
- .5 **Existing occupied buildings (depending upon their age) may contain designated substances and/or hazardous materials in thermal insulating materials and some manufactured products, such as vinyl asbestos floor tile. Any insulating materials, on pipes, fittings, boilers, tanks, ductwork, etc. may contain designated substances and/or hazardous materials and shall not be disturbed.**
- .6 **A survey of each building documenting the location and condition of designated substances and/or hazardous materials -containing materials is available for your mandatory review prior to commencing any work on premises.**

---

**1.24 PHASING OF WORK**

- .1 This work for this project shall be constructed in phases. Refer to the architectural drawings for phasing information and details. Misinterpretation of the drawings with respect to the extent of the phasing of the work shall not relieve the contractor of the work required to complete the entire contract.
- .2 Provide all necessary services or temporary services to suit phasing of construction with respect to all plumbing services and fire protection.
- .3 Life safety systems in the building are to remain fully operational in occupied areas for building staff and occupants during renovations.
- .4 Provide all necessary tests and certificates at completion of each phase to suit requirements of local authorities and consultants for occupancy of completed areas.

**1.25 CONFINED SPACES**

- .1 Certain areas of the building may be defined as a “Confined Space”. Any personnel working in these areas must have confined space training, appropriate equipment and undertake all work in conformance with appropriate codes and standards.
- .2 Refer to building documentation for any spaces deemed “Confined Space”.

**1.26 ENERGY EFFICIENCY**

- .1 The systems of this building must achieve the energy efficiency levels by conforming to ANSI/ASHRAE/IESNA 90.1 “Energy Standard for Buildings Except Low-Rise Residential Buildings” and Chapter 2 of Division 3 of SB-10 prescriptive method from the Ontario Building Code.
- .2 All equipment, products, and installations must conform to the Codes and Standards.

**END OF SECTION**

**Part 1            General**

**1.1            TESTS**

- .1 Give 48 hours written notice of date for tests.
- .2 Insulate or conceal work only after testing and approval by Consultant.
- .3 Conduct tests in presence of Consultant.
- .4 Bear costs including retesting and making good.
- .5 Piping:
  - .1 General: maintain test pressure without loss for 4 h unless otherwise specified.
  - .2 Test drainage, waste and vent piping to Ontario Building Code and authorities having jurisdiction.
  - .3 Test domestic hot, cold and recirculation water piping at 1-1/2 times system operating pressure or minimum 860 kPa (124.8 psi), whichever is greater.
- .6 Equipment: test as specified in relevant sections.

**1.2            SYSTEM START UP**

- .1 **Provide adjusting testing and start up of all equipment prior to testing and balancing (TAB) specified elsewhere.**
- .2 **Provide consultant with written notice verifying all equipment operation and installation is complete.**
- .3 **Start up shall be in presence of the following: owner or representative, contractor, building automation systems (BAS) contractor, and manufacturer's representative. Each person shall witness and sign off each piece of equipment. Consultant's attendance will be determined by consultant.**
- .4 Simulate system start up and shut down and verify operation of each piece of equipment.
- .5 Arrange with all parties and provide 72 hours notice for start up procedure.
- .6 Arrange with building automation systems contractor to sequence all components and ensure system operation.

**1.3            COMMISSIONING**

- .1 **Prepare, in writing, documentation of any deficiencies discovered during the commissioning process. Submit to consultant and Owner/Owner's Representative.**
- .2 **The Commissioning Process is detailed in *ASHRAE Guideline 1-1996 HVAC Commissioning Process*. The commissioning plan may be modified to reflect the actual construction schedule and design.**

- 
- .3 Provide a pre-functional test of all plumbing system and sub-system elements, including control devices, shall be checked for the following:**
- .1 Verify that each element has been properly installed, properly identified, and that all connections (including electrical) have been made correctly.**
  - .2 Verify that each element has been checked for proper lubrication, drive rotation, belt tension, control sequence, flow direction, or other conditions which may cause damage or reduce system performance.**
  - .3 Verify that tests, meter readings, and specific plumbing/mechanical/electrical performance characteristics agree with those required by equipment or system manufacturer.**
  - .4 Controls calibration to be completed in accordance with the specification.**
  - .5 The TAB shall be done in accordance with the specifications.**
- .4 Reports:**
- .1 The contractor shall be responsible for recording, documenting, and maintaining detailed inspection and testing data on the test documentation reports. The data record shall be comprehensive and concise.**
  - .2 All data must be recorded as soon as possible during the course of the inspection and testing.**
  - .3 All documentation shall have the date, time, and names of persons participating in the inspection and testing.**
- .5 Plumbing System Execution:**
- .1 Operate equipment and systems shall be tested in the presence of the owner's representative and the consultant to demonstrate compliance with specified requirements. To minimize the time of Commissioning Team members, testing shall be done in four seasonal single blocks of time insofar as possible.**
  - .2 Notify the consultant, in writing, fourteen (14) days prior to tests scheduled under requirements of this Section.**
  - .3 Testing shall be conducted under specified design operating conditions as recommended or approved by the consultant.**
  - .4 All elements of systems shall be tested to demonstrate that total systems satisfy all requirements of these Specifications. Testing shall be accomplished on hierarchical basis. Test each piece of equipment for proper operation, followed by each sub-system, followed by entire system, followed by any inter-ties of other major systems.**
  - .5 All special testing materials and equipment shall be provided by the appropriate contractor.**
  - .6 Provide three copies of all test reports and records to the consultant.**
- .6 The verification testing procedures shall address all operating characteristics of all plumbing equipment and systems.**

---

**1.4 DEMONSTRATION AND OPERATING AND MAINTENANCE INSTRUCTION**

- .1 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .2 Plumbing contractor to schedule and coordinate the demonstration all on the same day, starting at a pre-approved time and continuing consequently until complete.
- .3 Where specified elsewhere in this Division, qualified manufacturers' representatives who are knowledgeable about the project to provide demonstrations and instructions.
- .4 Use operation and maintenance manual, as-built drawings, audio visual aids, etc. as part of instruction materials.
- .5 Instruction duration time requirements as specified in appropriate sections.
- .6 Where deemed necessary, Consultants may record these demonstrations on video tape for future reference.

**1.5 TRIAL USAGE**

- .1 Consultant or owner may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Trial usage to apply to following equipment and systems:
  - .1 Domestic water
  - .2 Plumbing and drainage.

**1.6 DEFICIENCIES**

- .1 During the course of construction, the consultants will monitor construction and provide written reports of work progress, discussions, and instruction to correct work.
- .2 Instruction to correct work shall be done within the work period before the next review.
- .3 The contractor shall not conceal any work until inspected.
- .4 The contractor shall expedite 100% complete rough-in work and have inspected prior to concealing services and equipment especially above ceiling.
- .5 Upon completion of the project the consultant will do a final review. Upon receiving the final inspection report, the contractor must correct and sign back the inspection report indicating the deficiencies are completed. A re-inspection will only be done once consultant receives this in writing.

**1.7 EQUIPMENT INSTALLATIONS**

- .1 Unions or flanges: provide for ease of maintenance and disassembly.
- .2 Space for servicing, disassembly and removal of equipment and components: provide as recommended by manufacturer or as indicated.
- .3 Equipment drains: pipe to floor drains.
- .4 Install equipment, rectangular cleanouts and similar items parallel to or perpendicular to building lines.

## **1.8 MOUNTING HEIGHTS**

- .1 Mounting height of equipment is from finished floor to equipment unless specified or indicated otherwise. Coordinate with block coursing (if applicable).
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install plumbing equipment at following heights unless indicated otherwise.
  - .1 Standard water closets 350 (14") to top of bowl
  - .2 Barrier-free water closets 400 (16") to top of bowl
  - .3 Barrier-free water closets 450 (18") to top of seat lid
  - .4 Wall hung lavatory 787 (31") to rim
  - .5 Barrier-free wall hung lavatory 840 (33") max to top of rim  
737 (29") min underside of rim front  
685 (27") clear at 400 (8") from basin front  
350 (14") min clear under waste trap
  - .6 Hose bibbs +/- 600 (24")
  - .7 Barrier-free drinking fountains 840 mm (33") to rim  
Not less than 686 (27") under unit
  - .8 **Backflow preventors 900 – 1200 (3' – 4') to centerline of unit**

Also follow direction of architectural drawings and where discrepancies occur clarify prior to rough-in.

## **1.9 ANCHOR BOLTS AND TEMPLATES**

- .1 Supply anchor bolts and templates for installation by other divisions.

## **1.10 PROTECTION OF OPENINGS**

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

## **1.11 ELECTRICAL**

- .1 Electrical work to conform to Electrical Division including the following:
  - .1 Supplier and installer responsibility and related plumbing responsibility is indicated in Equipment Schedule on plumbing/mechanical and/or electrical drawings.
  - .2 Power wiring and conduit is specified in Electrical Division except for conduit, wiring and connections below 50 V which are related to control systems. Follow Electrical Division for quality of materials and workmanship.
  - .3 Electrically operated equipment shall be C.S.A. approved label. Special Inspection Label of Provincial Authority having jurisdiction will be accepted in lieu of C.S.A. approval. Each motor shall have an approved starter. Starter will be supplied and installed by Electrical Division unless otherwise indicated.
  - .4 **All starters for plumbing equipment to be provided by this contractor. Wired by Electrical Division.**

---

**1.12 CONTROL WIRING**

- .1 Furnish and install all components, devices, and control wiring for all plumbing, fire protection, HVAC equipment, HVAC systems, lighting, and other electrical loads to make all equipment operable to satisfaction of owner and consultant and to manufacturer's requirements and recommendations.
- .2 All electrical wiring and installations shall comply with local and national electrical codes.
- .3 Supply and install wiring as required for all devices and systems. Install wiring in EMT conduit and otherwise comply with all requirements of the Electrical Division. Approved plenum wire may be used for sensor and network communication wiring where it complies with appropriate building codes and regulatory authorities.
- .4 All wiring concealed in walls and chases, and all exposed wiring shall be run in conduit.
- .5 Provide recessed conduit and backer boxes where controls are wall mounted. Surface mounted boxes and conduit are acceptable in service rooms.
- .6 Free-run plenum rated cable shall be run in cable hangers where provided by electrical division or tied neatly to pipe and duct hangers in the ceiling. Avoid wiring that droops. Follow building lines and do not run wiring "as the crow flies".

**1.13 MOTORS**

- .1 Provide high efficiency motors for plumbing equipment.
- .2 If delivery of specified motor will delay delivery or installation of any equipment, install motor approved by Consultant for temporary use. Final acceptance of equipment will not occur until specified motor is installed.
- .3 Motors under 373 W, (1/2 hp): speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, voltage as indicated.
- .4 Motors 373 W, (1/2 hp) and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40°C (72°F), 3 phase, voltage as indicated.

**1.14 PIPING AND EQUIPMENT SUPPORTS**

- .1 Fabricate from structural grade steel meeting requirements of - Structural Steel Section. Submit structural calculations with shop drawings.
- .2 Mount base mounted equipment on chamfered edge housekeeping pads, minimum of 100 mm (4") high and 150 mm (6") larger than equipment dimensions all around. Concrete specified elsewhere.
- .3 Where housekeeping pads incorporate existing pads provide 10 mm dowels into existing pads. New pad height shall match existing.

**1.15 SLEEVES**

- .1 Pipe sleeves: at points where pipes pass through masonry, concrete or fire rated assemblies and as indicated. Grout sleeves in place.
- .2 Schedule 40 steel pipe.



- .3 Sleeves with annular fin continuously welded at midpoint:
  - .1 Through foundation walls.
  - .2 Where sleeve extends above finished floor.
  - .3 Through fire rated walls and floors.
- .4 Sizes: minimum 6 mm (1/4") clearance all around, between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Terminate sleeves flush with surface of concrete and masonry walls, concrete floors on grade and 25 mm (1") above other floors.
- .6 Fill voids around pipes:
  - .1 Caulk between sleeve and pipe in foundation walls and below grade floors with waterproof fire retardant non-hardening mastic.
  - .2 Where sleeves pass through walls or floors, provide space for firestopping. Where pipes/ducts pass through fire rated walls, floors and partitions, maintain fire rating integrity.
  - .3 Ensure no contact between copper tube or pipe and ferrous sleeve.
  - .4 Fill future-use sleeves with lime plaster or other easily removable filler.
  - .5 Coat exposed exterior surfaces of ferrous sleeves with heavy application of zinc rich paint to CGSB 1-GP-181M+Amdt-Mar-78.
- .7 Provide minimum 20 gauge duct sleeves where ducts pass through masonry concrete or fire rated assemblies. Maintain minimum 25 mm clearance all around or to the requirements of the authority having jurisdiction. Seal at wall as indicated.

#### **1.16 FIRE STOPPING**

- .1 This contractor shall work with all other contractors on the project in providing one common method of fire stopping all penetrations made in fire rated assemblies.
- .2 Approved fire stopping and smoke seal material in all fire separations and fire ratings within annular space between pipes, ducts, insulation and adjacent fire separation and/or fire rating.
- .3 Do not use cementitious or rigid seals around penetrations for pipe(s) or other equipment at all wall, floor, or ceiling penetrations.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barrier at fire separation.
- .5 Provide materials and systems capable of maintaining effective barrier against flame, smoke and gases. Ensure continuity and integrity of fire separation.
- .6 Comply with the requirements of CAN4-S115-M35, and do not exceed opening sized for which they have been tested.
- .7 Systems to have an F or FT rating (as applicable) not less than the fire protection rating required for closures in a fire separation. Provide "fire wrap" blanket around services penetrating fire walls. Extent of blanket must correspond to ULC recommendations.
- .8 The fire stopping materials are not to shrink, slump or sag and to be free of asbestos, halogens and volatile solvents.

- .9 Firestopping materials are to consist of a component sealant applied with a conventional caulking gun and trowel.
- .10 Fire stop materials are to be capable of receiving finish materials in those areas which are exposed and scheduled to receive finishes. Exposed surfaces are to be acceptable to consultant prior to application of finish.
- .11 Firestopping shall be inspected and approved by local authority prior to concealment or enclosure.
- .12 Install material and components in accordance with ULC certification, manufacturers instructions and local authority.
- .13 Submit product literature and installation material on fire stopping in shop drawing and product data manual. Maintain copies of these on site for viewing by installers and consultant.
- .14 Manufacturer of product shall provide certification of installation. Submit letter to the consultant.
- .15 Acceptable Alternate Manufacturers to approval of local authority:
  - .1 Minnesota Mining and Manufacturing
  - .2 Friesleeve Industries Inc.
  - .3 General Electric Pensil Firestop Systems
  - .4 International Protective Coatings Corp.
  - .5 Rectorseal Corporation (Metacaulk)
  - .6 Proset Systems
  - .7 3M
  - .8 AD Systems
  - .9 Hilti
- .16 Ensure firestop manufacturer representative performs onsite inspections and certifies installation. Submit inspection reports/certification at time of substantial completion.

**1.17 ESCUTCHEONS**

- .1 On pipes and ductwork passing through walls, partitions, floors and ceilings in exposed finished areas and on water and drain pipes inside millwork and cabinets.
- .2 Chrome or nickel plated brass or Type 302 stainless steel, one piece type with set screws.
- .3 Outside diameter to cover opening or sleeve.
- .4 Inside diameter to fit around finished pipe.

**1.18 PAINTING**

- .1 Refer to Section Interior Painting and specified elsewhere.
- .2 Apply at least one coat of corrosion resistant primer paint to ferrous supports and site fabricated work.

- .3 Apply two coats of paint to exposed piping service in service room(s). Base colour as specified in Pipe Identification Section.
- .4 Prime and touch up marred finished paintwork to match original.
- .5 Restore to new condition, or replace equipment at discretion of consultant, finishes which have been damaged too extensively to be merely primed and touched up.

#### **1.19 ACCESS DOORS**

- .1 Provide access doors to concealed plumbing equipment for operating, inspecting, adjusting and servicing.
- .2 Flush mounted 600 x 600 mm (24" x 24") for body entry and 300 x 300 mm (12" x 12") for hand entry unless otherwise noted. Doors to open 180°, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps.
- .3 Material:
  - .1 Special areas such as tiled or marble surfaces: use stainless steel with brushed satin or polished finish as directed by Consultant.
  - .2 Remaining areas: use prime coated steel.
  - .3 Fire rated areas: provide ULC listed access doors.
  - .4 Washrooms or high moisture area ceilings: Aluminum with mill finish suitable for painting.
- .4 Installation:
  - .1 Locate so that concealed items are accessible.
  - .2 Locate so that hand or body entry (as applicable) is achieved.
- .5 Acceptable materials:
  - .1 Le Hage
  - .2 Zurn
  - .3 Acudor
  - .4 Nailor Industries Inc.

#### **1.20 DIELECTRIC COUPLINGS**

- .1 General:
  - .1 To be compatible with and to suit pressure rating of piping system.
  - .2 Where pipes of dissimilar metals are joined.
- .2 Pipes NPS 50 mm (2") and under: isolating unions.
- .3 Pipes NPS 65 mm (2 1/2") and over: isolating flanges.

#### **1.21 DRAIN VALVES**

- .1 Locate at low points and at section isolating valves unless otherwise specified.
- .2 Minimum NPS 20 mm (3/4") unless otherwise specified: bronze, with hose end male thread and complete with vacuum air breaker and chain with cap.

- .3 Drain valves on potable water systems shall be complete with vacuum breaker.

#### **1.22 REPAIRS, CUTTING, AND RESTORATION**

- .1 Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
- .2 Each Section of this Division shall bear expense of cutting, patching, and repairing to install their work and/or replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.
- .3 Cutting, patching, repairing, and replacing pavements, sidewalks, roads, and curbs to permit installation of work of this Division is responsibility of Section installing work.
- .4 All patching, painting and making good of the existing walls, floors, ceilings, partitions and roof will be at the expense of this Contractor, but performed by the Contractor specializing in the type of work involved unless otherwise noted.

#### **1.23 EXISTING SYSTEMS**

- .1 Connections into existing systems to be made at time approved by Consultant. Request written approval of time when connections can be made.
- .2 Be responsible for damage to existing plant by this work.

#### **1.24 CLEANING**

- .1 Clean interior and exterior of all systems including strainers.
- .2 In preparation for final acceptance, clean and refurbish all equipment and leave in operating condition.

#### **1.25 DISCONNECTION AND REMOVAL**

- .1 Disconnect and/or remove equipment, piping, etc. as indicated.
- .2 Cap and conceal all redundant and obsolete connections.
- .3 Provide a list of equipment to be removed to the owner, for his acceptance of same. Remove all equipment from site, which the owner does not retain.
- .4 Store equipment to be retained by owner on site where directed by consultant.

#### **1.26 OWNER SUPPLIED EQUIPMENT**

- .1 Connect to equipment supplied by the owner and make operable.

#### **1.27 DEMOLITION**

- .1 The general requirements are indicated on the drawings and on the outline specification in Division 1.
- .2 The general execution of the demolition is to be carried out in a clean and efficient manner.

- .3 Demolition of existing ceiling, walls etc., to facilitate removal of existing services or equipment or installation of new to be kept to a minimum and then restored to match existing.**
- .4 All openings or holes created by removal of existing plumbing systems which are not being reused are to be patched with the same material surrounding surfaces.
- .5 All new holes and openings to facilitate plumbing systems are to be patched to match surrounding surfaces.
- .6 Protect all existing furnishings materials and equipment. Any damage occurring as a result of the work of this Division shall be repaired or replaced at the expense of this Division.
- .7 Where work involves breaking into or connecting to existing services, carry out work at times directed by the Owners in an expedient manner with minimum disruption to the facility and systems downtime.
- .8 Where unknown services are encountered, immediately advise Consultant and confirm findings in writing.
- .9 Where the location of any services has been shown on the plans, such information is not guaranteed. It is this Division's responsibility to verify locations, invert elevations, etc., immediately after moving on site. Should for any reason the information obtained necessitates changes in procedure or design, advise the Consultant at once. If verification of existing conditions is not done at the outset and any problems arise, the responsibility for same is entirely this Division's.

**1.28 VIDEO RECORDING OF NEW & EXISTING UNDERGROUND SERVICES**

- .1 Prior to final acceptance of the new underground plumbing system and prior to pouring the floor this contractor shall retain a qualified contractor to video tape the new, existing and revised sanitary and storm drainage piping and branch piping. Transfer all videotape information to USB.**
- .2 This contractor shall flush the new and existing storm and sanitary system to remove all debris prior to final video taping of systems.**
- .3 Provide 1 copy of USB.**
- .4 Identify video routing on As-built drawings.**

**1.29 LOCATION OF EXISTING UNDERGROUND SERVICES**

- .1 This contractor shall locate existing services prior to starting any work in the affected area.**
- .2 This contractor shall use a video camera for the existing storm and/or sanitary drainage at the indicated connection point to confirm location, size and invert of the existing piping.**

**1.30 EXISTING CONCRETE SLAB X-RAY/SCANNING**

- .1 This contractor shall retain the services of a qualified company to provide and X-ray and/or scan of the existing buried services in wall and/or floors prior to starting any work in the affected area.**

- .2 Failure to locate existing piping, conduit rebar etc., shall not relieve this contractor of repair of same prior to installing his service.
- .3 This contractor shall be responsible for all repairs and/or replacement of existing services caused by cutting the existing concrete slabs and/or walls.

#### **1.31 EXCAVATING AND BACKFILLING**

- .1 Provide all excavating and backfilling inside and outside the building for plumbing pipes, drains and equipment. All backfilling shall be new clean granular 'A' fill brought in specifically for the purpose of backfilling to the underside of floor slab. All backfilling shall be compacted at intervals not more than 150 mm (6") layer to the satisfaction of the Consultant.
- .2 Provide excavating and backfilling outside the building with granular A brought in specifically for backfilling to a minimum of 450 mm (18") over the pipe. Backfilling outside building over and above the 450 mm (18") backfill as previously specified herein shall be by the Plumbing Contractor as specified under Division 2. Where backfilling outside the building is not specified under Division 2 the plumbing contractor shall provide new clean granular 'A' fill to grade level.
- .3 Bottoms of trenches shall be excavated so that the pipe will be supported on a 150 mm (6") compacted bed of clean granular 'A' fill. Provide all necessary pumping to maintain excavation free of water.
- .4 Should water be encountered during excavation, the plumbing contractor shall provide all labour and material, including all equipment required for dewatering the excavation. After the water has been removed, this Contractor shall install a 300 mm (12") base of compacted 50 mm (2") clear stone covered with filter cloth before installing backfill as detailed and/or as specified.
- .5 Be responsible for all weather protection required to install piping and/or equipment to the satisfaction of the Consultant.
- .6 Be responsible for providing all clear stone or granular 'A' material suitable for application to replace existing soil not suitable for backfilling above the 450 mm (18") bedding material.

#### **1.32 CONFINED SPACES**

- .1 Certain areas of the building may be defined as a "Confined Space". Any personnel working in these areas must have confined space training, appropriate equipment and undertake all work in conformance with appropriate codes and standards.
- .2 Refer to building documentation for any spaces deemed "Confined Space".

#### **1.33 EXISTING SYSTEM DRAINAGE**

- .1 Drain all existing piping and drainage systems including all related equipment as required to facilitate system renovations.
- .2 Disposal of existing system shall be to the requirements of the local and/or provincial regulations.

---

**1.34 DOMESTIC HW SYSTEM BALANCING**

- .1 Meet all requirements as specified for balancing of hydronic systems.
- .2 Locations of equipment measurements: To include, but not be limited to, following as appropriate: Inlet and outlet of each heater, tank, pump, circulator, at each controller, controlled device.
- .3 At each circuit setter balancing valve.
- .4 Locations of systems measurements to include, but not be limited to, following as appropriate: main, main branch, branch, sub-branch.

**1.35 BALANCING OTHER PLUMBING SYSTEM**

- .1 Plumbing systems:
  - .1 Pressure booster systems: test for capacity and pressures under all conditions and at all times.
- .2 Recirculating Systems pump flows, pressures

**1.36 COOPERATION WITH OTHER TRADES**

- .1 Give full cooperation to other trades and furnish in writing to other trades, with copies to the engineer, any information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay.
- .2 Where plumbing work will be installed in close proximity to, or will interfere with work of other trades, assist in working out space conditions to make a satisfactory adjustment. Prepare composite working drawings and sections at a suitable scale, not less than ¼ inches = 1-foot – 0-inches, clearly showing how the plumbing work is to be installed in relation to the work of other trades. If work is installed before coordinating with other trades, or if it causes any interference with work of other trades, make the necessary changes in the work to correct the conditions and bear all costs.
- .3 Furnish to other trades necessary templates, patterns, setting drawings, and shop details for the proper installation of work and for coordinating adjacent work.

**1.37 WATERPROOFING SEAL MATERIALS**

- .1 Modular, expanding mechanical seal assemblies consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and pipe sleeve or wall opening, assembled with stainless steel bolts and pressure plates and designed so when bolts are tightened the links expand to seal the opening watertight. Select seal assemblies to suit pipe size and sleeve size or wall opening size.
- .2 Standard of quality assurance manufacturers are:
  - .1 Thunderline Corp. (Power Plant Supply Co.) "Link Seal" Model S-316
  - .2 The Metraflex Co. "MetraSeal" type ES
  - .3 Or approved equivalent.

**1.38 SLEEVE, CUT, AND FORMED OPENING LOCATION DRAWINGS**

- .1 Prepare and submit for review, drawings indicating size and location of required sleeves, recesses, and formed openings in poured or precast concrete work.
- .2 Such drawings are to be completely and accurately dimensioned and relate sleeve, recesses, and formed openings to suitable grid lines and elevation datum, and are to take into account structural items such as grade beams, column caps, and column drop slabs.
- .3 Begin to prepare such drawings immediately upon notification of acceptance of bid and award of Contract.

**1.39 SUSTAINABLE CONSTRUCTION**

- .1 Construction Waste Management:
  - .1 Recycle all waste materials to avoid land fill sites where possible.
  - .2 All metal contents shall be recycled.
  - .3 All cardboard and paper shall be recycled.
  - .4 All plastic packaging shall be recycled.
  - .5 All wood shall be directed to the appropriate recycled wood section at the landfill site.
- .2 This contractor is responsible for their own waste management system and cost associated with the disposal. This can be their own on site system, daily removal, back to shop, or a communal system shared with other contractors on site.
- .3 In all cases the cost to remove materials on site are the cost of this contractor.

**1.40 FREEZE PROTECTION**

- .1 Do not run lines in outside walls, or locations where freezing may occur. Piping next to outside walls shall be in furred spaces with insulation between the piping and the outside wall. Insulation of piping shall not be considered freeze protection.

**1.41 SCAFFOLDING, RIGGING, AND HOISTING**

- .1 Provide all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished; remove same from premises when no longer required. Conform to OSHA requirements and standards.

**END OF SECTION**



**Part 1            General**

**1.1                REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 American Society for Testing and Materials
  - .1 ASTM A53/A53M, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
  - .2 ASTM A105/A105M, Specification for Carbon Steel Forgings for Piping Applications.

**1.2                PRODUCT DATA**

- .1 Submit product data in accordance with general requirements.
- .2 Indicate for each item as applicable:
  - .1 Manufacturer, model number, line contents, pressure and temperature rating.
  - .2 Movement handled; axial, lateral, angular and the amounts of each.
  - .3 Nominal size and dimensions including details of construction and assembly.

**1.3                CLOSEOUT SUBMITTALS**

- .1 Submit maintenance data in accordance with general requirements.
- .2 Data to include:
  - .1 Servicing requirements, including any special requirements, stuffing box packing, lubrication and recommended procedures.

**Part 2            Products**

**2.1                SLIP TYPE EXPANSION JOINTS**

- .1 Application: for axial pipe movement, as indicated.
- .2 Repacking: under full line pressure.
- .3 Body and packing housings: Class 150, 1Mpa carbon steel pipe to ASTM A53/A53M, Grade B. Wall thickness to match pipe and with raised face slip-on flanges to match pipe.
- .4 Slip or traverse sleeves: carbon steel pipe to ASTM A53/A53M, Grade B, hard chrome plated.
- .5 Anchor base: construction steel, welded to body.
- .6 Guides (internal and external): embody into packing housing with concentric alignment of slip or traverse sleeve with packing housing.
- .7 Extension limit stop: stainless steel, to prevent over-extension with accessible and removable pins.

- .8 Packing rings: 6 minimum, PTFE (teflon) or graphite impregnated non-asbestos fiber.
- .9 Thermal plastic packing: PTFE (teflon) or graphite impregnated non-asbestos fiber slug supplied loose.
- .10 Lubricating fittings: pet cocks with grease nipple.
- .11 Plunger body and plunger:
  - .1 Plunger body: heavy wall carbon steel welded to body.
  - .2 Plunger: carbon steel with hex head for use with socket wrench.
- .12 Lubricant: to manufacturer's recommendations.
- .13 Lubricant gun: complete with hose assembly.
- .14 Drip connection: 20 MPa (2900 psi) forged steel to ASTM A105. Include half coupling with drain plug.
- .15 Lubricant fittings, plunger, gun not required for low friction self lubricating packing.

## **2.2 BELLOWS TYPE EXPANSION JOINTS**

- .1 For axial, lateral or angular movements, as indicated.
- .2 Maximum operating pressure: 1034 kPa (150 psi).
- .3 Maximum operating temperature: 200°C (392°F).
- .4 Type A: free flexing, factory tested to 1½ times maximum working pressure. Furnish test certificates.
- .5 Type B: externally pressurized, constant volume, pressure balanced, designed to eliminate pressure thrust, factory tested to 1.5 times maximum working pressure. Furnish test certificates.
- .6 Bellows:
  - .1 Multiple bellows, hydraulically formed, two ply, austenitic stainless steel for specified fluid, pressure and temperature, water treatment and pipeline cleaning procedures.
- .7 Reinforcing or control rings:
  - .1 2 piece nickel iron.
- .8 Ends:
  - .1 Slip-on flanges to match pipe.
- .9 Liner:
  - .1 Austenitic stainless steel in direction of flow.
- .10 Shroud:
  - .1 Carbon steel, painted.

## **2.3 FLEXIBLE CONNECTION**

- .1 Application: to suit motion.
- .2 Minimum length in accordance with manufacturer's recommendations to suit offset.
- .3 Inner hose: stainless steel corrugated.
- .4 Braided wire mesh stainless steel outer jacket.
- .5 Diameter and type of end connection: as indicated.
- .6 Operating conditions:
  - .1 Working pressure: 1034 kPa (150 psi).
  - .2 Working temperature: 250°C (482°F).
  - .3 To match system requirements.

## **2.4 ANCHORS AND GUIDES**

- .1 Anchors:
  - .1 Provide as indicated.
- .2 Alignment guides:
  - .1 Provide as indicated.
  - .2 To accommodate specified thickness of insulation.
  - .3 Vapour barriers, jackets to remain uninterrupted.

## **2.5 EXPANSION COMPENSATORS (EXP)(2"-4")**

- .1 All welded packless guided construction complete with multi ply stainless steel bellows.
- .2 Operating temperature (700°F).
- .3 Provide model HP3 for steel pipe and model HBFF3 for copper pipe.
- .4 Movement capability of 4" axial. Welded ends.
- .5 Material to match piping system.
- .6 Acceptable materials:
  - .1 Metraflex HP
  - .2 Mark David Canada
  - .3 Senior Flexonics

## **2.6 EXPANSION COMPENSATORS (6"-16")**

- .1 All welded packless guided construction complete with multi ply stainless steel bellows.
- .2 Operating temperature (700°F).
- .3 Movement capability of 4" axial. Welded ends.
- .4 Material to match piping system.

- .5 Acceptable materials:
  - .1 Metraflex Metragator
  - .2 Mark David Canada
  - .3 Senior Flexonics

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 Install expansion joints with cold setting, as indicated as instructed by Consultant. Make record of cold settings.
- .2 Install expansion joints and flexible connections in accordance with manufacturer's instructions.
- .3 Install pipe anchors and guides as indicated. Anchors to withstand 150% of axial thrust.

#### **3.2 APPLICATION**

- .1 Provide on all vibration isolated equipment.
- .2 Provide where requested by equipment manufacturers installation manuals.
- .3 Install in accordance with manufacturer's recommendations.

#### **3.3 THERMAL EXPANSION**

- .1 Provide in long runs of hot water mains exceeding 100 ft. in length.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 American National Standards Institute/ American Society of Mechanical Engineers (ANSI/ASME)
  - .1 ANSI/ASME B31.1, Power Piping, (SI Edition).
- .3 American Society for Testing and Materials (ASTM)
  - .1 ASTM A 125, Specification for Steel Springs, Helical, Heat-Treated.
  - .2 ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .3 ASTM A 563, Specification for Carbon and Alloy Steel Nuts.
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
  - .1 MSS SP-58, Pipe Hangers and Supports - Materials, Design, Manufacture Selection, Application, and Installation.

**1.2            DESIGN REQUIREMENTS**

- .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
- .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP-58.
- .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.
- .4 Design hangers and supports to support systems under all conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
- .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment to be in accordance with MSS SP-58.

**1.3            SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with general requirements.
- .2 Submit shop drawings and product data for following items:
  - .1 All bases, hangers and supports.
  - .2 Connections to equipment and structure.
  - .3 Structural assemblies.

**1.4            MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.

**Part 2 Products**

**2.1 GENERAL**

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS-SP-58.
- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

**2.2 PIPE HANGERS**

- .1 Finishes:
  - .1 Pipe hangers and supports: to ANSI & ULC requirements
  - .2 Ensure steel hangers in contact with copper piping are copper plated.
- .2 Upper attachment structural: Suspension from upper flange of I-Beam or joist.
  - .1 Cold piping NPS 50 mm (2") maximum: Ductile iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
    - .1 Rod: 10 mm (3/8") UL listed
  - .2 Cold piping NPS 65 mm (2 1/2") or greater, all hot piping: Malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed & FM approved.
- .3 Upper attachment structural: Suspension from upper flange of I-Beam.
  - .1 Cold piping NPS 50 mm (2") maximum: Ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed.
  - .2 Cold piping NPS 65 mm (2 1/2") or greater, all hot piping: Malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nuts.
- .4 Upper attachment to concrete.
  - .1 Ceiling: Carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm (1/4") minimum greater than rod diameter.
  - .2 Concrete inserts: wedge shaped body with knockout protector plate ULC listed. Note: Rapidex and Siporex are not considered concrete. Should one of these systems be encountered, piping/ductwork and/or equipment shall be supported from adjacent walls or from supplemental steel provided by this contractor attached to the adjacent walls/structure.
- .5 Shop and field-fabricated assemblies.
  - .1 Trapeze hanger assemblies: ASME B31.1.
  - .2 Steel brackets: ASME B31.1.
- .6 Hanger rods: threaded rod material to MSS SP-58.
  - .1 Ensure that hanger rods are subject to tensile loading only.
  - .2 Provide linkages where lateral or axial movement of pipework is anticipated.

- .7 Pipe attachments: material to MSS SP-58.
  - .1 Attachments for steel piping: carbon steel.
  - .2 Attachments for copper piping: copper plated black steel.
  - .3 Use insulation shields for all piping.
  - .4 Oversize pipe hangers and supports to accommodate thermal insulation. Provide 1.5 mm (16 gauge) saddles.
- .8 Adjustable clevis: material to MSS SP-58 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
  - .1 Ensure "U" has hole in bottom for rivetting to insulation shields.

## **2.3 RISER CLAMPS**

- .1 Steel or cast iron pipe: black carbon steel to MSS-SP-58, type 42, UL listed.
- .2 Copper pipe: carbon steel copper plated to MSS-SP-58, type 42.
- .3 Bolts: to ASTM A 307.
- .4 Nuts: to ASTM A 563.

## **2.4 INSULATION PROTECTION SHIELDS**

- .1 Insulated cold piping:
  - .1 64 kg/m<sup>2</sup> (13.12 lbs/ft<sup>2</sup>) density insulation plus insulation protection shield to: MSS SP-69, galvanized sheet carbon steel. Length designed for maximum 3 m (10') span.
- .2 Insulated hot piping:
  - .1 Curved plate 300 mm (12") long, with edges turned up, welded-in centre plate for pipe sizes NPS 300 mm (12") and over, carbon steel to comply with MSS SP-58.

## **2.5 EQUIPMENT SUPPORTS**

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of miscellaneous metals, specified herein. Submit calculations with shop drawings.

## **2.6 OTHER EQUIPMENT SUPPORTS**

- .1 From structural grade steel meeting requirements of structural steel section specified herein.
- .2 Submit structural calculations with shop drawings.

## **2.7 MANUFACTURER**

- .1 Acceptable materials:
  - .1 Grinnell
  - .2 Anvil
  - .3 Myatt
  - .4 Taylor

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install in accordance with:
  - .1 Manufacturer's instructions and recommendations.
- .2 Clamps on riser piping:
  - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
  - .2 Bolt-tightening torques to be to industry standards.
  - .3 Steel pipes: Install below coupling or shear lugs welded to pipe.
  - .4 Cast iron pipes: Install below joint.
- .3 Clevis plates:
  - .1 Attach to concrete with 4 minimum concrete inserts at each corner.
- .4 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

### **3.2 HANGER SPACING**

- .1 Plumbing piping: most stringent requirements of Canadian Plumbing Code, Provincial Code, or authority having jurisdiction.
- .2 Copper piping: up to NPS 15 mm (1/2"): every 1.5 m (5').
- .3 Within 300 mm (12") of each elbow and:

Maximum Pipe Size: NPS	Spacing Steel	Maximum Spacing Copper
up to 32 mm (1 1/4")	2.1 m (7')	1.8 m (6')
40 mm (1 1/2")	2.7 m (9')	2.4 m (8')
50 mm (2")	3.0 m (10')	2.7 m (9')
65 mm (2 1/2")	3.6 m (12')	3.0 m (10')
80 mm (3")	3.6 m (12')	3.0 m (10')
90 mm (3 1/2")	3.9 m (13')	3.3 m (11')
100 mm (4")	4.2 m (14')	3.6 m (12')
125 mm (5")	4.8 m (16')	
150 mm (6")	5.1 m (17')	



### **3.3 HANGER INSTALLATION**

- .1 Install hanger so that rod is vertical under operating conditions.
- .2 Adjust hangers to equalize load.
- .3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.
- .4 Do “NOT” support piping, ductwork and equipment from roof deck, on bottom chord of floor and/or roof joist and/or from OWSJ bridging. Provide structural member between joist.

### **3.4 HORIZONTAL MOVEMENT**

- .1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4mm (5/32") from vertical.
- .2 Where horizontal pipe movement is less than 15 mm (1/2"), offset pipe hanger and support so that rod hanger is vertical in the hot position.

### **3.5 FINAL ADJUSTMENT**

- .1 Adjust hangers and supports:
  - .1 Ensure that rod is vertical under operating conditions.
  - .2 Equalize loads.
- .2 Adjustable clevis:
  - .1 Tighten hanger load nut securely to ensure proper hanger performance.
  - .2 Tighten upper nut after adjustment.
- .3 C-clamps:
  - .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- .4 Beam clamps:
  - .1 Hammer jaw firmly against underside of beam.

**END OF SECTION**

**Part 1 General**

**1.1 APPLICATION**

- .1 Seismic restraint is becoming more prominent with improved soil testing equipment. Seismic requirement is not site specific by geographical area but determined by site soil conditions.
- .2 Where the structural engineer or architect documents have  $I_e \cdot S_a(0.2) \cdot F_a < 3.5$  seismic is not required on the plumbing, mechanical, electrical, or fire protection systems.
- .3 Where the structural engineer or architect documents have  $I_e \cdot S_a(0.2) \cdot F_a \geq 3.5$  seismic is required on the plumbing, mechanical, electrical, or fire protection systems.
- .4 Seismic will always be required on fire protection systems when required by NFPA codes.
- .5 Seismic will always be required on any "Disaster Relief Building." For example, hospitals, police stations, ambulance building, etc.
- .6 When it is unclear in the tender documents request information from the structural engineer or architect for clarification.

**1.2 SECTION INCLUDES**

- .1 Seismic Requirements for single rod hanger support for conduit, pipe and other similar systems.
- .2 Seismic Requirements for trapeze type supports for cable tray, conduit, pipe and other similar systems.
- .3 Seismic requirements for all plumbing equipment and piping.

**1.3 RELATED WORK SPECIFIED ELSEWHERE**

- .1 Vibration Isolation Measures.

**1.4 REFERENCE STANDARDS**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 National Building Code of Canada (NBC).
- .3 Canadian Standards Association
  - .1 CSA S832, Seismic Risk Reduction of Operation and Functional Components (OFCs) of Buildings.
  - .2 CAN/CSA-S16.1 Limit States Design of Steel Structures
  - .3 CAN3-S136 Design of Cold Steel Structural Members
  - .4 CSA W47.1 Certification of Companies for Fusion Welding of Steel
  - .5 CSA W59 Welded Steel Construction

- .4 American Society of Testing and Materials
  - .1 ASTM A653/S653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (galvannealed) by the Hot Dip Process.
  - .2 ASTM A879M Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface.
  - .3 ASTM A307 Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .4 ASTM A325M Specification for Structural Bolts, Heat Treated 830MPa Minimum Tensile Strength.
- .5 All local codes.
- .6 FEMA: Seismic Restraint Installation Manuals 412. 413. & 414
  - .1 FEMA 412: Installing Seismic Restraints for Plumbing/Mechanical Equipment
  - .2 FEMA 413: Installing Seismic Restraints for Electrical Equipment
  - .3 FEMA 414: Installing Seismic Restraints for Duct and Pipe
- .7 ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.).
- .8 ASHRAE Applications Handbook; Seismic and Wind Restraint Design Chapter.

## 1.5 DEFINITIONS

- .1  $A_v$ : Effective peak velocity related acceleration coefficient BOCA, SBC Code.
- .2  $S_1$ : Mapped Long Period Seismic Acceleration Coefficient IBC, TI-809-04, ASCE7.
- .3  $S_s$ : Mapped Short Period Seismic Acceleration Coefficient IBC, TI-809-04, ASCE7.
- .4  $v$ : Zonal Velocity Coefficient NBC-Canada.
- .5 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 VISCMA 102-2007: Static Qualification Standards for Obtaining a VISCMA Compliant Seismic Component Rating.
- .7  $Z$ : Seismic Zone defines Seismic Coefficient  $C_a$  used by UBC Code.

## 1.6 PERFORMANCE REQUIREMENTS

- .1 Design Ground Acceleration Coefficient ( $A_v$ ,  $S_s$ ,  $v$ , or  $Z$  depending on Code = X.XX).
- .2 (If IBC or TI-809-04) Design Long Period Ground Acceleration Coefficient ( $S_1$  = X.XX).
- .3 Design Soil Type = ( $S_a$ ,  $S_b$ ,  $S_c$ ,  $S_d$ ) as appropriate. (If NBC Canada, the Foundation Factor).
- .4 Importance or Performance Factor appropriate to structure =  $I_p$  = X.XX.
- .5 If UBC Zone 4, Proximity to Fault and, if less than 10km, Fault Type.
- .6 Schedule or drawings indicating critical ( $I_p$  = 1.5) Duct/Piping systems, including systems whose importance factor may be increased by proximity to critical components.

## **1.7 DESCRIPTION OF SYSTEM**

- .1 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 plumbing 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.
- .2 The work under this section shall include furnishing all labour, materials, tools, appliances, and equipment, and performing all operations necessary for the complete execution of the installation of seismic snubber restraint assemblies as shown, detailed, and/or scheduled on the drawing and/or specified in this section of the specifications.
- .3 All seismic snubber restraint assemblies shall meet the following minimum requirements:
  - .1 The snubber/restrained isolator for isolated equipment shall include a resilient element that will ensure that no un-cushioned shock can occur (this does not include cable restraints).
  - .2 It shall be possible to visually inspect the resilient material for damage and allow for replacement, if necessary.
  - .3 All snubbers are to include a maximum air gap of 0.25 in (6 mm).
  - .4 Seismic restraint systems shall be designed to offer seismic restraint in all directions, unless otherwise noted.
  - .5 Seismic restraint capacities to be verified by an independent test laboratory or certified by a registered Professional Engineer to ensure that the design intent of this specification is realized. Verification shall be by one of the following methods:
    - .1 An NRTL (National Recognized Testing Laboratory), or laboratory recommended by VISCMA.
    - .2 Certified by a Professional Engineer with at least 5 years of experience, using industry standard methods of analysis, which employ common engineering practices. Adherence to the ratings standard within ASHRAE SPC171 and VISCMA 102-2007 is required.
    - .3 By a nationally recognized agency, such as VISCMA, that has reviewed and approved the restraint.

## **1.8 SYSTEM DESIGN**

- .1 Seismic restraint manufacturer shall be responsible for the structural design of 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 furnish, to the seismic restraint manufacturer, 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 furnished 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, ductwork and equipment is to be restrained to meet code requirements. At a minimum, the seismic restraint manufacturer 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 of the housekeeping pad is to be coordinated with the seismic restraint manufacturer to ensure that adequate edge distances exist in order to obtain the desired equipment anchor capacities.

#### **1.9 SEISMIC BRACING AND SUPPORT DESIGN REQUIREMENTS**

- .1 Seismic restraint designer shall co-ordinate all attachments with the structural engineer of record.
- .2 Design analysis shall include calculated dead loads, static seismic loads, and capacity of materials utilized for the connection of the equipment or system to the structure.
- .3 Analysis shall detail anchoring methods, bolt diameter, and embedment depth.
- .4 All seismic restraint devices shall be designed to accept without failure the forces calculated per the applicable building code and as summarized in Section 3.01.
- .5 Friction from gravity loads shall not be considered resistance to seismic forces.
- .6 Fire protection systems shall meet the requirements of NFPA-13 and NFPA-14. Sway bracing used for seismic restraint purposes must be fitted with provisions to resist the vertical force component of the diagonal brace. Single diagonal brace for seismic restraint will not be approved.

#### **1.10 QUALITY ASSURANCE**

- .1 The contractor shall provide pre-engineered seismic restraint systems to meet total design lateral force requirements for support and restraint of piping, conduit, cable trays and other similar systems and equipment where required by the applicable building code.
- .2 System Supports/Restraints: Firms regularly engaged in the manufacture of products of the types specified in this section, whose products have been in satisfactory use in similar service for not less than 5 years.
- .3 Bolted framing channels and fittings shall have the manufacturers name, part number, and material heat code identification number stamped in the part itself for identification. Material certification sheets and test reports must be made available by the manufacturer upon request.
- .4 Only companies experienced in performing the work of this section shall do the installation.
- .5 All seismic restraint installations shall be independently reviewed by the Owners Representative for compliance with project specifications.

### **1.11 SUBMITTALS**

- .1 Product Data: Include Seismic Rating Curve for each seismically rated isolator or restraint component.
- .2 Samples: The contractor shall submit samples of specified seismic snubber devices for approval.
- .3 Shop Drawings shall include the following:
  - .1 Design Calculations: Calculate requirements for selecting seismically rated vibration isolators and seismic restraints. Certification documents to be signed and sealed by a qualified Professional Engineer with at least 5 years of experience in the design of seismic restraints. Professional engineer shall have local jurisdiction and provide periodic field review and final certification upon completion of the project. All costs and fees associated with the engineering shall be the responsibility of this contractor.
  - .2 Vibration Isolation Bases: Dimensional drawings including anchorage and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads.
  - .3 Seismic-Restraint Details: Detailed submittal drawings of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors. Include ratings for loads.
  - .4 Equipment Manufacturer Seismic Qualification Certification: The Equipment Manufacturer must submit certification that each piece of provided equipment will withstand seismic forces identified in "Performance Requirements" Article above. Include the following:
    - .1 Basis for Certification: Indicate whether the "withstand" certification is based on actual test assembled components or on calculations.
    - .2 Indicate the equipment is certified to be durable enough to:
      - .1 structurally resist the design forces and/or
      - .2 will remain functional after the seismic event.
  - .5 Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - .6 Detailed description of the assumed equipment anchorage devices on which the certification is based.

### **1.12 DELIVERY, STORAGE, AND HANDLING**

- .1 Deliver strut systems, pipe hangers and components carefully to avoid breakage, denting, and scoring finishes. Do not install damaged equipment.
- .2 Store strut systems, pipe hangers and components in original cartons and in clean dry space; protect from weather and construction traffic.

### **1.13 WORK FURNISHED BUT NOT INSTALLED**

- .1 The materials and systems specified in this section shall be purchased by the plumbing contractor from a single seismic snubber restraint materials manufacturer to assure sole source responsibility for the performance of the seismic restraints used.

- .2 The materials and systems specified in this section can, at the contractor's option, be installed by the subcontractor who installs the seismic restraint systems.

#### **1.14 COORDINATION**

- .1 Coordinate size, shape, reinforcement and attachment of all housekeeping pads supporting seismically rated equipment. Concrete shall have a minimum compressive strength of 3,000 psi or as specified by the consultant.
- .2 Coordinate with seismic restraint manufacturer to locate and size structural supports underneath seismically restrained equipment (e.g. roof curbs, cooling towers, and other similar equipment).

#### **1.15 INSTALLATION**

- .1 Installation of all seismic restraint materials specified herein shall be accomplished following the manufacturer's written instructions. Installation instructions shall be submitted to the engineer for approval prior to the beginning of the work.

### **Part 2 Products**

#### **2.1 MATERIALS**

- .1 Unless otherwise specified materials used in the Work shall conform to the following:
  - .1 All steel rolled sections and steel plates shall conform to CAN/CSA G40.21M-300W
  - .2 All steel hollow structural steel sections shall conform to CAN/CSA G40.21-350W Class C
  - .3 Structural steel bolts, nuts and washers shall conform to ASTM A325M
  - .4 Weld electrodes shall be SMAW-E-E480XX and SAW-F480-EXXX.

#### **2.2 ACCEPTABLE MANUFACTURERS**

- .1 All seismic snubbers and combination restraint/vibration isolation materials specified herein shall be provided by a single manufacturer to assure sole source responsibility for the proper performance of the materials used. Manufacturer is to be a member of VISCMA.
- .2 Anchor types and sizes are to be per the design data as provided by the seismic restraint manufacturer.
- .3 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 all requirements as listed in this specification.
- .4 Kinetics Noise Control Inc.
- .5 Cooper 'B' Line.
- .6 Unistrut Building Systems.
- .7 Mason Industries.

## 2.3 SEISMIC SNUBBER TYPES

### GENERAL

(Isolator/Snubber Types contained herein are per ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.) Handbook, HVAC Applications, Seismic and Wind Restraint Design)

- .1 Type A, Coil Spring Isolator Incorporated Within a Ductile Iron or Cast Aluminum Housing.
  - .1 Cast iron or aluminum housings are brittle when subjected to shock loading and are therefore not approved for seismic restraint applications.
- .2 Type B, Coil Spring Isolator Incorporated Within A Steel Housing
  - .1 Spring isolators shall be seismic control restrained spring isolators, incorporating a single or multiple coil spring element, having all of the characteristics of free standing coil spring isolators as specified in the vibration isolation portion of this specification. Springs shall be restrained using a housing engineered to limit both lateral and vertical movement of the supported equipment during an earthquake without degrading the vibration isolation capabilities of the spring during normal equipment operating conditions.
  - .2 Vibration isolators shall incorporate a steel housing and neoprene snubbing grommet system designed to limit motion to no more than ¼" (6 mm) in any direction and to prevent any direct metal-to-metal contact between the supported member and the fixed restraint housing. The restraining system shall be designed to withstand the seismic design forces in any lateral or vertical direction without yield or failure. Where the capacity of the anchorage hardware in concrete is inadequate for the required seismic loadings, a steel adapter base plate to allow the addition of more or larger anchors will be fitted to fulfill these requirements. In addition to the primary isolation coil spring, the load path will include a minimum ¼" (6 mm) thick neoprene pad.
  - .3 Spring elements shall be colour coded or otherwise easily identified. Springs shall have a lateral stiffness greater than 1.2 times the rated vertical stiffness and shall be designed to provide a minimum of 50% overload capacity. Non-welded spring elements shall be epoxy powder coated and shall have a minimum of a 1000-hour rating when tested in accordance with ASTM B-117.
  - .4 To facilitate servicing, the isolator will be designed in such a way that the coil spring element can be removed without the requirements to lift or otherwise disturb the supported equipment.
  - .5 Spring isolators shall be Model FHS as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (2).



- .3 Type C, Coil Spring Isolator Incorporated Within a Steel Housing
  - .1 Spring isolators shall be seismic control restrained spring isolators, incorporating one or more coil spring elements, having all the characteristics of free standing coil spring isolators per the vibration isolation section of this specification, for equipment which is subject to load variations and/or large external forces. Isolators shall consist of one or more laterally stable steel coil springs assembled into fabricated welded steel housings designed to limit movement of the supported equipment in all directions.
  - .2 Housing assembly shall be made of fabricated steel members and shall consist of a top load plate complete with adjusting and leveling bolts, adjustable vertical restraints, isolation washers, and a bottom load plate with internal non-skid isolation pads and holes for anchoring the housing to the supporting structure. Housing shall be hot dipped galvanized for outdoor corrosion resistance. Housing shall be designed to provide a constant free and operating height within  $\frac{1}{8}$ " (3 mm).
  - .3 The isolator housing shall be designed to withstand the project design seismic forces in all directions.
  - .4 Coil spring elements shall be selected to provide static deflections as shown on the vibration isolation schedule or as indicated or required in the project documents. Spring elements shall be colour coded or otherwise easily identified. Springs shall have a lateral stiffness greater than 1.2 times the rated vertical stiffness and shall be designed to provide a minimum of 50% overload capacity. Non-welded spring elements shall be epoxy powder coated and shall have a minimum of a 1000-hour rating when tested in accordance with ASTM B-117.
  - .5 Spring isolators shall be Model FLS and FLSS as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (3).
- .4 Type D, Coil Spring Isolator Incorporated with Integral Seismic Restraint
  - .1 Spring isolators shall be single or multiple coil spring elements which have all of the characteristics of freestanding coil spring isolators as specified in the vibration isolation portion of this specification, incorporating lateral and vertically restrained seismic housing assemblies. Spring elements shall be readily replaceable without the need to list or remove the supported equipment.
  - .2 Restraint housing shall be sized to meet or exceed the force requirements of the application and shall have the capability of accepting coil springs of various sizes, capabilities, and deflections as required to meet the required isolation criteria. All spring forces shall be contained within the coil/housing assembly, and the restraint anchoring hardware shall not be exposed to spring generated forces under conditions of no seismic force. Spring element leveling adjustment shall be accessible from above and suitable for use with a conventional pneumatic or electric impact wrench.

- .3 Restraint element shall incorporate a steel housing with elastomeric elements at all dynamic contact points. Elastomeric elements shall be replaceable. Restraint shall allow  $\frac{1}{4}$ " (6 mm) free motion in any direction from the neutral position. Restraint shall have an overturning factor (ratio of effective lateral snubber height to short axis anchor spacing) of 0.33 or less to ensure optimum anchorage capacity.
- .4 Spring isolators shall be Model FMS as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (4).
- .5 Type E, All Direction Neoprene Isolator
  - .1 Vibration Isolators shall be neoprene, molded from oil resistant compounds, designed to operate within the strain limits of the isolator so to provide the maximum isolation and longest life expectancy possible using neoprene compounds. Isolators shall include encapsulated cast-in-place top steel load transfer plate for bolting to equipment and a steel base plate with anchor holes for bolting to the supporting structure. Ductile iron or cast aluminum components are not acceptable alternatives and shall not be used due to brittleness when subjected to shock loading.
  - .2 Isolator shall be capable of withstanding the design seismic loads in all directions with no metal-to-metal contact.
  - .3 Isolator shall have minimum operating static deflections as shown on the project Vibration Isolation Schedule or as otherwise indicated in the project documents and shall not exceed published load capacities.
  - .4 Neoprene isolators shall be Model RQ as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections .2.01, 2.02 and 2.03 (5).
- .6 Type F, Light Capacity All Direction 3-Axis External Seismic Snubber Assembly
  - .1 Equipment shall be restrained against excessive movement during a seismic event by the use of 3-axis resilient snubbers, designed to withstand the project required seismic forces. A minimum of two (2) snubbers are to be used at each equipment installation, oriented to effectively restrain the isolated equipment in all three directions, and additional snubbers shall be used as required by seismic design conditions.
  - .2 Snubbers shall be of interlocking steel construction and shall be attached to the equipment structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral and vertical equipment movement at each snubber location to a maximum of  $\frac{1}{4}$ " (6 mm) in any direction.
  - .3 Snubbers shall include a minimum  $\frac{1}{4}$ " (6 mm) thick resilient neoprene pads to cushion any impact and to avoid any potential for metal-to-metal contact. Maximum neoprene bearing pressure shall not exceed 1500 pounds / sq. inch (10.4 N / sq. mm). Snubber shall be capable of withstanding an externally applied seismic force of up to 3,000 pounds (1360 kg) in any direction. Snubber shall be installed only after the isolated equipment is mounted, piped, and operating so as to ensure that no contact occurs during normal equipment operation.

- .4 Three-axis seismic snubbers shall be Model HS-5 as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and 2.01, 2.02, and 2.03 (6).
- .7 Type G, Lateral 2-Axis External Seismic Snubber Assembly
  - .1 Equipment shall be restrained against excessive lateral movement during a seismic event by the use of 2-axis horizontal resilient snubbers, designed to withstand the project required seismic forces. A minimum of two (2) snubbers are to be used at each equipment installation, oriented to effectively restrain the isolated equipment in all horizontal directions, and additional snubbers shall be used as required by seismic design conditions.
  - .2 Snubbers shall be interlocking steel construction and shall be attached to the equipment structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral equipment movement at each snubber location to a maximum of ¼" (6 mm).
  - .3 Snubbers shall include a minimum of ¼" (6 mm) thick resilient neoprene pads to cushion any impact and to avoid any potential for metal-to-metal contact. Snubber shall be installed only after the isolated equipment is mounted, piped, and operating so as to ensure that no contact occurs during normal equipment operation.
  - .4 Two-axis lateral seismic snubbers shall be Model HS-2 as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (7).
- .8 Type H, Heavy Capacity All Direction 3-Axis External Seismic Snubber Assembly
  - .1 Equipment shall be restrained against excessive vertical and horizontal movement during a seismic event by the use of 3-axis resilient snubbers, designed to withstand the project required seismic forces. A minimum of two (2) snubbers are to be used at each equipment installation, oriented to effectively restrain the isolated equipment in all three directions, and additional snubbers shall be used as required by seismic design conditions.
  - .2 Snubbers shall be of welded interlocking steel construction and shall be attached to the equipment structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral and vertical equipment movement at each snubber location to a maximum of ¼" (6 mm) in any direction.
  - .3 Snubbers shall include resilient neoprene pads with a minimum thickness of ¼" (6 mm) to cushion any impact and to avoid any potential for metal-to-metal contact. Snubber shall be capable of withstanding an externally applied seismic force up to 10,000 pounds (4,540 kg) in any direction. Snubber shall be installed only after the isolated equipment is mounted, piped, and operating so as to ensure that no contact occurs during normal equipment operation.
  - .4 Three-axis seismic snubbers shall be Model HS-7 as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (8).

- .9 Type I, Horizontal 1-Axis External Seismic Snubber Assembly
- .1 Equipment shall be restrained against excessive horizontal one-axis movement during a seismic event by the use of single-axis resilient snubbers, designed to withstand the project required seismic forces. A minimum of four (4) snubbers are to be used at each equipment installation, oriented to effectively restrain the isolated equipment in all lateral directions.
  - .2 Snubbers shall be of steel construction and shall be attached to the equipment structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral equipment movement at each snubber location in the direction of impact to a maximum of ¼" (6 mm).
  - .3 Snubbers shall include resilient neoprene pads with a minimum thickness of ¼" (6 mm) to cushion any impact and to avoid any potential for metal-to-metal contact. Snubber shall be installed only after the isolated equipment is mounted, piped, and operating so as to eliminate any contact during normal equipment operation.
  - .4 Single-axis seismic snubbers shall be Model HS-1 as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (9).
- .10 Type J, Cable Restraints for Suspended Piping and Ductwork
- .1 Seismic wire rope cable restraints shall consist of steel wire strand cables, sized to resist project seismic loads, arranged to offer seismic restraint capabilities for piping, ductwork, and suspended equipment in all lateral directions.
  - .2 Building and equipment attachment brackets at each end of the cable shall be designed to permit free cable movement in all directions up to a 45-degree misalignment. Protective thimbles shall be used at sharp connection points as required to eliminate potential for dynamic cable wear and strand breakage.
  - .3 Restraints shall be sized to the capacity of the cable or to the capacity of the anchorage, whichever is lesser.
  - .4 Seismic wire rope connections shall be made using overlap wire rope "U" clips or seismically rated tool-less wedge insert lock connectors.
  - .5 Vertical suspension rods shall be braced as required to avoid potential for buckling due to vertical "up" forces. Braces shall be structural steel angle uniquely selected to be of sufficient strength to prevent support rod bending. Brace shall be attached to the vertical suspension rod by a series of adjustable straps. Clips shall be capable of securely locking brace to suspension rod without the need for hand tools.
  - .6 Where clevis hanger brackets are used for seismic restraint attachment, they will be fitted with clevis internal braces to prevent buckling of the hanger brackets.
  - .7 Seismic cable shall be as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.03 through 1.07 inclusive, and sections 2.01, 2.02, and 2.03 (10).

- .8 Seismic cable building and equipment attachment brackets shall be Model KSCA, KSCU, or KSCC as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (10).
- .9 Seismic cable concrete anchor bolts shall be Model KCAB Wedge, Model KCCAB Cracked Concrete, or Model KUAB Undercut, as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (10).
- .10 Seismic wire rope connectors shall be (Model KWRC - 'U' clamp) / (Model KWGC - Tool-less wedge lock) as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (10).
- .11 Seismic vertical suspension stiffener rod clips shall be Model KHRC as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (10).
- .12 Clevis Internal Braces shall be Model KCHB as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (10).

## **2.4 SEISMIC BRACING COMPONENTS**

- .1 Steel strut shall be 1-5/8 wide in varying heights and mig-welded combinations as required to meet load capacities and designs. A material heat code, part number, and manufacturer's name shall be stamped on all strut and fittings to maintain traceability to material test reports.
- .2 Material for epoxy painted strut: ASTM A1011, SS, Grade 33.
- .3 Material for pre-galvanized strut: ASTM A653, SS, Grade 33.
- .4 Material for hot-dip galvanized strut: ASTM A1011, SS, Grade 33 and hot-dip galvanized after fabrication in accordance with ASTM A123.
- .5 Material for fittings and accessories: ASTM A907, Grade 33, Structural Quality or ASTM A1011, SS, Grade 33.
- .6 Fittings and accessories: Products shall be of the same manufacturer as strut and designed for use with that product.

## **2.5 UNIFORM BUILDING CODE REQUIREMENTS**

- .1 Seismic Zone Factor to Table 16-I for area of jurisdiction.
- .2 Soil Profile Type to Table 16-J for area of jurisdiction.
- .3 Seismic Importance Factor to Table 16-K for area of jurisdiction.
- .4 Component Amplification Factor to Table 16-O for area of jurisdiction.
- .5 Component Response Mod. Factor to Table 16-O for area of jurisdiction.
- .6 Seismic Coefficient to Table 16-Q for area of jurisdiction.

- .7 The total height of the structure ( $h_r$ ) and the height of the system to be restrained within the structure ( $h_x$ ) shall be determined in co-ordination with architectural plans and the General Contractor.
- .8 Forces shall be calculated for individual supports using the above information. Exceptions to Table 16-O may be utilized. However, all use of exceptions shall be noted on submitted seismic bracing plan documents.

### **Part 3 Execution**

#### **3.1 GENERAL INSTALLATION**

- .1 Installation of all seismic restraint materials specified in this section shall be accomplished as per the manufacturer's written instructions.
- .2 Refer to FEMA Manuals 412, 413, and 414 for typical industry standard installation guidelines.
- .3 Upon completion of installation of all seismic restraint materials and before start-up of restrained equipment, all debris shall be cleaned from beneath all protected equipment, leaving equipment free to contact snubbers/restraints.
- .4 Torque anchor bolts according to anchor manufacturer's written instructions to resist seismic forces.
- .5 All seismic restraint systems shall be installed in strict accordance with the manufacturer's seismic restraint guidelines manual and all certified submittal data.
- .6 Prior to installation, bring to the architect's/engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.
- .7 Brace support rods when necessary to accept compressive loads. Welding of compressive braces to the vertical support rods is not acceptable.
- .8 Seismic restraints shall be attached to the structural system. Looping restraints around the system is not acceptable.
- .9 Do not brace a system to two independent structures such as ceiling and wall.
- .10 Provide appropriately sized openings in walls, floors, and ceilings for anticipated seismic movement. Provide fire seal systems in fire-rated walls.
- .11 Seismic restraint cables shall be adjusted such that they are not visibly slack, or the flexibility is approximately 25mm under thumb pressure for a 1500mm cable length (equivalent ratio for other cable lengths).
- .12 All seismic restraint cables shall be at least 25mm clear of all other equipment and services.

#### **3.2 EQUIPMENT INSTALLATION**

- .1 All external utility connections to restrained equipment shall be designed to allow differential seismic motion without damage to the equipment or utility connections.

- .2 Adjust isolators and restraints after piping systems have been filled and equipment is at its operating weight, following the manufacturer's written instructions.
- .3 After equipment installation is completed, adjust limit stops following manufacturer's written instructions so that they are out of contact during normal operation.
- .4 Adjust snubbers according to manufacturer's written instructions.
- .5 Installation of seismic restraints shall not cause any change in position of equipment, resulting in stresses or misalignment.
- .6 No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration isolation system specified.
- .7 Do not install any seismic restraint for equipment, cable trays or conduit that compromises isolation specified.

### **3.3 PIPING INSTALLATION**

- .1 Hold down clamps must be used to attach pipe to all trapeze members before applying restraints.
- .2 Branch lines may not be used to restrain main lines.
- .3 Piping crossing building seismic or expansion joints, passing from building to building, or supported from different portions of the building shall be installed to allow differential support displacements without damaging the pipe, equipment connections, or support connections. Pipe offsets, loops, anchors, and guides shall be installed as required to provide specified motion capability and limit motion of adjacent piping.
- .4 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.

### **3.4 FASTENING TO STRUCTURE**

- .1 Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast in place inserts, or wedge-type concrete anchors. Consult structural engineer of record.
- .2 Overstressing of the building structure shall not occur from overhead support of equipment. Bracing attached to structural members may present additional stresses. The contractor shall submit loads to the structural engineer of record for approval in this event.
- .3 Coring is not permitted for the installation of concrete anchors. Use ground penetrating radar or equivalent method of embedment item detection to locate all embed items including reinforcing steel and electrical conduits. Concrete reinforcing steel and electrical conduits shall not be cut or damaged under any circumstances.
- .4 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.
- .5 If mounting hole diameter exceeds bolt diameter by more than 0.125" (3 mm), reduce clearance in hole with epoxy grout, flanged elastomeric bushings or welded washer.

- .6 Housekeeping Pads must be adequately reinforced and adequately sized for proper installation of equipment anchors. Refer to seismic restraint manufacturer's written instructions.

### **3.5 INSPECTION**

- .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 Upon completion of the installation of all seismic restraint devices herein specified, the local representative of the seismic restraint manufacturer shall, at the contractor's request, inspect the completed system and report in writing any installation errors, improperly selected snubber devices, or other fault in the system which could affect the performance of the system.
- .3 The installing contractor shall submit a report upon request 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.
  - .1 Guidelines for Mechanical Systems", Second Edition (Remaining Codes).

**END OF SECTION**



**Part 1            General**

**1.1            SHOP DRAWINGS**

- .1      Submit shop drawings in accordance with general requirements.
- .2      Provide separate shop drawings for each isolated system complete with performance and product data.

**Part 2            Products**

**2.1            GENERAL**

- .1      Size and shape of bases type and performance of vibration isolation to be as indicated.
- .2      To be of the same manufacturer for all isolation.
- .3      Acceptable materials:
  - .1          Korfund
  - .2          Vibro-Acoustics
  - .3          Vibron

**2.2            ELASTOMERIC PADS**

- .1      Type EP4 - rubber-steel-rubber; 10 mm (3/8") minimum thick rubber bonded to 1.5 mm (16 gauge) steel plate; 30 durometer natural rubber, waffle or ribbed; holes sleeved with isolation washers; maximum loading 415 kPa (60.2 psi).
- .2      Acceptable materials:
  - .1          Korfund
  - .2          IAC Acoustics
  - .3          Vibro-Acoustics
  - .4          Vibron

**2.3            SPRINGS**

- .1      Design stable springs so that ratio of lateral to axial stiffness is equal to or greater than 1.2 times the ratio of static deflection to working height. Select for 50% travel beyond rated load. Units to be complete with levelling devices.
- .2      Ratio of height when loaded to diameter of spring to be between 0.8 to 1.0.
- .3      Cadmium plate for all installations.
- .4      Colour code springs.

**2.4            HORIZONTAL THRUST RESTRAINT**

- .1      Spring and elastomeric element housed in box frame; assembly complete with rods and angle brackets for equipment and ductwork attachment; provision for adjustment to limit maximum start and stop movement to 10 mm (3/8").

- .2 Arrange restraints symmetrically on either side of unit and attach at centerline of thrust.
- .3 Acceptable materials:
  - .1 Korfund
  - .2 IAC Acoustics
  - .3 Vibron
  - .4 Vibro-Acoustics

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.
- .2 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
- .3 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm (1") minimum static deflection as follows:
  - .1 Up to NPS 100 mm (4"): first 3 points of support. NPS 125 mm (5") to NPS 200 mm (8"): first 4 points of support. NPS 250 mm (10") and Over: first 6 points of support.
  - .2 First point of support shall have a static deflection of twice deflection of isolated equipment, but not more than 50 mm (2").
- .4 Where isolation is bolted to floor use vibration isolation rubber washers.
- .5 Block and shim level bases so that ductwork and piping connections can be made to a rigid system at the operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

#### **3.2 SITE VISIT**

- .1 Manufacturer to visit site and provide written certification that installation is in accordance with manufacturer's instructions and submit report to Consultant.
- .2 Provide Consultant with notice 24 h in advance of visit.
- .3 Make adjustments and corrections in accordance with written report.

#### **3.3 TESTING**

- .1 Experienced and competent sound and vibration testing professional engineer to take vibration measurement for HVAC systems after start up and TAB of systems to Testing Adjusting and Balancing Section.
- .2 Vibration measurements shall be taken for equipment-listed below:
- .3 Provide Consultant with notice 48 h in advance of commencement of tests.

- .4 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations including sound curves.
- .5 Submit complete report of test results including sound curves.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 Canadian General Standards Board (CGSB).
  - .1 CAN/CGSB-1.60, Interior Alkyd Gloss Enamel.
  - .2 CAN/CGSB-24.3, Identification of Piping Systems.
- .3 Canadian Standards Association (CSA).
  - .1 Natural Gas and Propane Installation Code CSA B149.1.
- .4 National Fire Protection Association
  - .1 NFPA 13, Installation of Sprinkler Systems.
  - .2 NFPA 14, Standpipe and Systems.

**1.2            PRODUCT DATA**

- .1 Submit product data in accordance with General Requirements.
- .2 Product data to include paint colour chips, all other products specified in this section.

**1.3            PRODUCT LITERATURE**

- .1 Submit product literature in accordance with General Requirements.
- .2 Product literature to include nameplates, labels, tags, lists of proposed legends.

**Part 2            Products**

**2.1            MANUFACTURER'S EQUIPMENT NAMEPLATES**

- .1 Metal or plastic lamicoid nameplate mechanically fastened to each piece of equipment by manufacturer.
- .2 Lettering and numbers to be raised or recessed.
- .3 Information to include, as appropriate:
  - .1 Equipment: Manufacturer's name, model, size, serial number, capacity.
  - .2 Motor: voltage, Hz, phase, power factor, duty, frame size.

**2.2            SYSTEM NAMEPLATES**

- .1 Colours:
  - .1 Black letters, white background (except where required otherwise by applicable codes).

- .2 Construction:
- .1 3 mm (1/8") thick laminated plastic, matte finish, with square corners, letters accurately aligned and machine engraved into core.
- .3 Sizes:
- .1 Conform to following table:
- | Size | No. of<br>Sizes mm (") | Height of<br>Line mm (") | Letters mm (") |
|------|------------------------|--------------------------|----------------|
| 1    | 10 x 50 (3/8" x 2")    | 1 (3/64")                | 3 (1/8")       |
| 2    | 15 x 75 (1/2" x 3")    | 1 (3/64")                | 6 (1/4")       |
| 3    | 15 x 75 (1/2" x 3")    | 2 (5/64")                | 3 (1/8")       |
| 4    | 20 x 100 (3/4" x 4")   | 1 (3/64")                | 10 (3/8")      |
| 5    | 20 x 100 (3/4" x 4")   | 2 (6/64")                | 6 (1/4")       |
| 6    | 20 x 200 (3/4" x 8")   | 1 (3/64")                | 10 (3/8")      |
| 7    | 25 x 125 (1" x 5")     | 1 (3/64")                | 15 (1/2")      |
| 8    | 25 x 125 (1" x 5")     | 2 (5/64")                | 10 (3/8")      |
| 9    | 32 x 200 (1 1/4" x 8") | 1 (3/64")                | 20 (3/4")      |
- .2 Use maximum of 25 letters/numbers per line.
- .4 Locations:
- .1 Equipment in Mechanical Rooms: Use size #9.
- .2 Equipment above ceiling: use size #1 riveted to ceiling suspension system.

## 2.3 EXISTING IDENTIFICATION SYSTEMS

- .1 Apply existing identification system to new work.
- .2 Where existing identification system does not cover for new work, use identification system specified this section.

## 2.4 IDENTIFICATION OF PIPING SYSTEMS

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
- .2 Legend:
- .1 Block capitals to sizes and colours listed in CAN/CGSB-24.3.
- .3 Arrows showing direction of flow:
- .1 Outside diameter of pipe or insulation less than 75 mm (3"): 100 mm (4") long x 50 mm (2") high.
- .2 Outside diameter of pipe or insulation 75 mm (3") and greater: 150 mm (6") long x 50 mm (2") high.
- .3 Use double-headed arrows where flow is reversible.
- .4 Extent of background colour marking:
- .1 To full circumference of pipe or insulation.
- .2 Length to accommodate pictogram, full length of legend and arrows.

- .5 Materials for background colour marking, legend, arrows:
- .1 Pipes and tubing 20 mm (3/4") and smaller: Waterproof and heat-resistant pressure sensitive plastic marker tags.
  - .2 All other pipes: Pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150°C (300°F) and intermittent temperature of 200°C (395°F).
- .6 Colours and Legends:
- .1 Where not listed, obtain direction from Consultant.
  - .2 Colours for legends, arrows: To following table:
- |                    |         |         |
|--------------------|---------|---------|
| Background colour: | Legend: | Arrows: |
| Yellow             | White   | Black   |
| Green              | White   | Black   |
| Red                | White   | Black   |
- .7 **Pictograms:**
- .1 **Where required, to Workplace Hazardous Materials Information System (WHMIS) regulations.**
- .8 Background colour marking and legends for piping systems:

CONTENTS	BACKGROUND COLOUR MARKING	
	MARKING	LEGEND
Continuous blow-off		CONT. BLOW-OFF
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HW recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Domestic tempered supply	Green	DOM. TEMPERED
Trap Primer	Green	TRAP PRIMER
Storm water	Green	STORM
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT

## 2.5 VALVES, CONTROLLERS

- .1 Brass tags with 15 mm (1/2") stamped identification data filled with black paint.
- .2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.
- .3 Provide adhesive coloured tab (max. size 15 mm) indication on ceiling to locate valves/equipment above. Same applies to grid. Colour to be approved by consultant.

---

**2.6 LANGUAGE**

- .1 Identification to be in English.

**Part 3 Execution**

**3.1 TIMING**

- .1 Provide identification only after all painting specified has been completed.

**3.2 INSTALLATION**

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Provide ULC and/or CSA registration plates as required by respective agency.

**3.3 NAMEPLATES**

- .1 Locations:
  - .1 In conspicuous location to facilitate easy reading and identification from operating floor.
- .2 Standoffs:
  - .1 Provide for nameplates on hot and/or insulated surfaces.
- .3 Protection
  - .1 Do not paint, insulate or cover in any way.

**3.4 LOCATION OF IDENTIFICATION ON PIPING SYSTEMS**

- .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels not more than 1.7 m (5'-8") intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
- .2 Adjacent to each change in direction.
- .3 At least once in each small room through which piping or ductwork passes.
- .4 On both sides of visual obstruction or where run is difficult to follow.
- .5 On both sides of separations such as walls, floors, partitions.
- .6 Where system is installed in pipe chases, ceiling spaces, galleries, other confined spaces, at entry and exit points, and at each access opening.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 Identification to be easily and accurately readable from usual operating areas and from access points.
  - .1 Position of identification to be approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

**3.5 VALVES, CONTROLLERS**

- .1 Valves and operating controllers, except at plumbing fixtures, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.
- .2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Consultant. Provide one copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively. Where existing numbering system is installed start new numbering system at 100.

**END OF SECTION**



**Part 1 General****1.1 SHOP DRAWINGS AND AS-BUILT DRAWINGS**

- .1 Conform to General Requirements Section for shop drawings and as-built drawings requirements.

**1.2 INSTALLATION INSPECTION AND EQUIPMENT VERIFICATION**

- .1 The Plumbing Contractor shall co-ordinate with the Consultant who will inspect the plumbing installation.
- .2 The Plumbing Contractor shall complete the equipment verification forms for each piece of equipment. The forms shall be included in the operating and maintenance manual. The equipment data shall include:
  - Manufacturers name, address and telephone number
  - Distributors name, address and telephone number
  - Make, model number and serial number
  - Pumps - RPM, impeller sizes, rated flow
  - Electrical - volts, amps, fuse size, overload size
  - Any other special characteristics.

**1.3 PLUMBING AND DRAINAGE SYSTEM TESTING**

- .1 The plumbing and drainage system shall be tested in accordance with the Plumbing Code under the Ontario Water Resources Act and the specification.
- .2 The Mechanical Contractor shall notify the Building Inspector when systems are available for testing. The Mechanical Contractor shall document all tests performed and shall arrange for the Building Inspector to sign for tests completed. The forms shall be forwarded to the Consultant.

**1.4 THE CONTRACTOR'S TESTING OF PIPING SYSTEMS**

- .1 Test all piping systems in accordance with all applicable plumbing codes and General Requirements section.
- .2 All tests for the systems shall be performed in the presence of the Consultant or Commissioning Consultant. Complete the testing forms and forward to the Consultant.

**1.5 THE INDEPENDENT CONTRACTORS TESTING AND BALANCING OF WATER SYSTEMS**

- .1 Conform with the specification section, Testing, Adjusting and Balancing.
- .2 The Independent Contractor shall be hired by the plumbing contractor and shall report to the Commissioning Consultant.

**1.6 CLOSEOUT SCHEDULE**

- .1 The Plumbing Contractor shall include the schedule for all tests and equipment start-up tests in the construction schedule.

.2 All testing forms and reports associated with the plumbing systems shall be directed to the Consultant with copies to the Owner and Consultant.

.3 The forms and reports to be issued shall include:

- Shop drawings, issued and accepted
- Equipment verification forms
- Testing forms
- Reports resulting from tests
- Testing schedule
- Equipment Start-up Forms

#### **1.7 OPERATION AND MAINTENANCE MANUAL**

.1 Conform to General Requirements section for the Operating and Maintenance Manual requirements.

#### **1.8 OPERATOR TRAINING**

.1 Conform to General Requirements section for requirements for Instruction to Operating Staff.

.2 The training shall be conducted in a classroom and at the equipment or system.

.3 Training will begin when the operating and maintenance manuals have been delivered to The Owner and approved by the Consultant.

.4 Each training session shall be structured to cover:

The operating and maintenance manual

- Operating procedures
- Maintenance procedures
- Trouble-shooting procedures
- Spare parts required
- Submit a course outline to the Consultant before training commences. Provide course documentation for up to eight people.

.5 The training sessions shall be scheduled and co-ordinated by the Plumbing Contractor.

.6 Training shall be provided for the following systems:

<u>System</u>	<u>Minimum Training Times</u>
Pumps	2 hours
Water Heaters	2 hours
Emergency Showers & Eye Wash	2 hours

**1.9 COMMISSIONING CONSULTANT**

- .1 A Commissioning Consultant (CC) reports to the Owner.
- .2 The CC responsibilities shall include:
  - preparing the commissioning plan
  - co-ordinating with the contractor to schedule tests
  - preparing a test form manual
  - witnessing selected tests
  - receiving all test forms
  - conducting performance test
  - co-ordinating the contractors training
  - chair commissioning meetings
- .3 The Plumbing Contractor shall co-operate with the CC.
- .4 The Plumbing Contractor shall provide assistance to the CC and have personnel available during the performance testing procedure. Each mechanical system shall be tested in the operational mode.
- .5 Performance testing shall begin when all systems have been completed, tested by the Mechanical Contractor and the Consultant has completed their final review.

**1.10 PLUMBING SYSTEM DEMONSTRATION AND TURNOVER**

- .1 Refer to General Requirements section, Mechanical Project Completion.
- .2 The system demonstration and turnover to The Owner shall occur when:
  - The installation is complete
  - The acceptance test conducted by the Mechanical Consultant has been completed successfully
  - The Commissioning Consultant system performance testing has been completed successfully
  - Training has been completed
  - Operating and Maintenance Manuals have been accepted
  - Shop-drawings have been updated
  - As-built drawings have been completed
- .3 The systems demonstration shall be conducted by the Mechanical Contractor and the manufacturers. The demonstration shall cover a demonstration of equipment installation and operation.

**1.11 WARRANTIES**

- .1 Equipment and system warranties shall not begin until the system demonstration and turnover has been conducted successfully and accepted by The Owner.
- .2 The Mechanical Contractor shall fill out the warranty form listing the equipment and systems and the start and finishing dates for warranty.
- .3 Refer to the general conditions specification section for the requirements during the warranty period.

**1.12 CLOSEOUT PROCESS ALLOCATION**

- .1 The mechanical contractor closeout process shall follow section 22 02 51 'Fire Protection General Requirements'.
- .2 The Mechanical Contractor shall submit all test and verification forms. The Consultant will use these forms to calculate percentage complete.
- .3 The monies shall not be paid out until the performance testing, O & M manuals, systems demonstration, and training including all required paperwork have been completed to the satisfaction of the consultant. Refer to General Requirements section for contract breakdown.

**END OF SECTION**

**Part 1            General**

**1.1            RELATED DOCUMENTS**

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2            REFERENCES**

- .1 Heating cable must conform to CSA 22.2 No.130-03 (latest edition).

**1.3            SUMMARY**

- .1 Section includes heat tracing for fire-suppression piping with self-regulating, parallel resistance.

**1.4            SUBMITTALS**

- .1 Product Data: For each type of product.
- .2 Include:
  - .1 Heating cable data sheet.
  - .2 Connection kits and accessories data sheet.
  - .3 Controller data sheet.
  - .4 Controller wiring diagram.
- .3 Include rated capacities, operating characteristics, and furnished specialties and accessories.
- .4 Schedule heating capacity, length of cable, and electrical power requirement for each electric heating cable required.
- .5 Include heat loss calculations for each pipe including pipe and insulation characteristics, heat loss, and watts per foot supplied by the heating cable.
- .6 Shop Drawings: For electric heating cable.
  - .1 Include plans, elevations, and sections.
  - .2 Include diagrams for power, signal, and control wiring.
  - .3 Manufacturer to produce detailed design as described below.
- .7 Design Submittal: Submit signed and sealed design layout drawings by the qualified professional engineer responsible for their preparation. Delegated design submittals include:
  - .1 Heat Trace Circuit Layout Drawings, including:
    - .1 Location/Identification of area to be traced.
    - .2 Heater circuit number.
    - .3 Electrical load.
    - .4 Heater catalog numbers.
    - .5 Heater termination points.

- .6 Start-up temperature.
  - .7 Location of all components.
  - .8 Material list and quantities of all components.
  - .9 Heating cable layout.
  - .10 Design parameters.
  - .11 Insulation type and thickness.
  - .12 Position of all components.
  - .13 Material schedule listing all components and quantities used.
  - .14 Panel ID number.
- .8 Minimum heat trace capacity shall be 8 watts per foot irrespective of heat loss calculation.
- .9 Pipe Freeze Protection Detail Drawings: Project-specific Detail Drawings, including details showing:
- .1 Installation and positioning of all components.
  - .2 Proper amounts of tracing for valves, pumps, flanges, fittings, instruments, etc.
  - .3 Junction box layouts.
- .10 Control Panel Drawings: Drawings for each control panel shall include the following:
- .1 Physical arrangement and detail drawings.
  - .2 Complete power and control wiring diagrams showing all internal wiring connections for electrical and instrument components in each control panel. All wires, terminals, and devices shall be numbered and tagged in accordance with system elementary diagrams.
- .11 System Wiring Diagram: Project-specific drawings including:
- .1 Interconnect of all major components.
  - .2 Assignment of circuiting.
  - .3 Connection of circuit wiring in terminal blocks.
  - .4 Connection of sensor wiring.
  - .5 Connection of external alarm wiring.
- .12 Controller Setpoint Schedule showing the following:
- .1 Circuit addresses.
  - .2 Circuit set points.
  - .3 **Circuit alarms and settings.**
- .13 Testing Instructions and Reporting Form: Provide documentation for use in preinstallation testing of heat-tracing system.

## 1.5 CLOSEOUT SUBMITTALS

- .1 Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.
- .2 Testing: Completed system test report.

## **1.6 QUALITY ASSURANCE**

- .1 Manufacturer Qualifications:
  - .1 ISO-09001 registered.
  - .2 Provide products consistent with UL 515A, CSA 22.2 No 130-16, and IEEE 515.1 requirements.
- .2 Installer Qualifications:
  - .1 System Installer to have complete understanding of product and product literature from manufacturer or authorized representative prior to installation.
  - .2 Electrical connections to be performed by licensed electrician.
- .3 Certification: System (Heating Cable and Connection Kits): c-UL-us Listed for freeze protection of standpipes, mains, and branch fire sprinkler piping.

## **1.7 DELIVERY, STORAGE, AND HANDLING**

- .1 Deliver products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying the following:
  - .1 Product and Manufacturer.
  - .2 Length/Quantity.
  - .3 Lot Number.
  - .4 Installation and operation Manual.
  - .5 Safety Data Sheet (SDS).
- .2 Store heating cable in clean, dry location with a temperature range of -18° to 60 C (0 to 140 F).
- .3 Protect heating cable ends from moisture ingress until final termination of the heating cable is complete.

## **1.8 WARRANTY**

- .1 Manufacturer Limited Warranty: Manufacturer agrees to repair or replace heat tracing products listed below that fail in materials or workmanship within specified warranty period.
- .2 Covered Products Include:
  - .1 Heating cables, connection kits, and accessories.
  - .2 Thermostats, controllers, panels, contactors, sensors, and accessories.
- .3 Warranty Period: Two years from date of Ready for Takeover.
- .4 Manufacturer's Extended Warranty: Provide Owner an extended product warranty for heat-tracing products for a period of 10 years from date of Ready for Takeover.

## **Part 2 Products**

### **2.1 SYSTEM DESCRIPTION**

- .1 Complete pipe freeze protection system for insulated pipes exposed to the risk of freezing. System consists of a self-regulating heating cable, connection kits, accessories, and energy-efficient control and monitoring controller. The heating cable shall have a polyolefin jacket for aboveground fire sprinkler piping, including standpipes, mains, and branch fire sprinkler piping. The monitoring controller must be suitable for integration into the BAS.

### **2.2 PERFORMANCE REQUIREMENTS**

- .1 Manufacturer to design complete and functional heat-tracing system. Design must be signed and sealed by a professional engineer.

### **2.3 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES (TYPE-1)**

- .1 Basis of design product: Raychem or nVent XL-Trace.
- .2 Comply with UL 515A, CSA 22.2 No 130-16, and IEEE 515.1 requirements.
- .3 Heating Element: Pair of parallel No. 16 AWG, nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Cable shall be capable of crossing over itself once without overheating.
- .4 Electrical Insulating Jacket: Flame-retardant modified polyolefin.
- .5 Ground Braid: Tinned-copper braid. Minimum 70 percent for ground path and mechanical ruggedness.
- .6 Outer Jacket: Modified polyolefin with ultraviolet inhibitor. Outer jacket to be printed with cable model number, agency listings, batch number, and meter marks (for ease of installation within maximum circuit length).
- .7 Maximum Operating Temperature (Power On): 68 C (154 F) for and 8 W/ft. (26 W/m) or 12 W/ft was required to suit load.
- .8 Maximum Exposure Temperature (Power Off): 85 C (185 F).
- .9 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- .10 Capacities and Characteristics:
  - .1 Nominal Heat Output at 10 C (50 F): 8 W/ft. (26° W/m) minimum. Provide higher as required based on heat loss calculations.
  - .2 Piping Diameter: Refer to plans.
  - .3 Electrical Characteristics for Single-Circuit Connection:
    - .1 Volts: 208
    - .2 Phase: Single.



## **2.4 HEATING CABLE CONNECTION KITS**

- .1 Basis-of-Design Product: RAYCHEM; RayClic.
- .2 Provide power connections, splices/tees, and end seal kits to properly connect and terminate heating cable circuit along specified length of piping.
- .3 Install splices, tees, and crosses underneath pipe insulation with service loops installed to allow for future service of piping.
- .4 Connection kits shall be rated NEMA 4X to prevent water ingress and corrosion. All components shall be UV stabilized and shall not require cutting into heating-cable core to expose bus wires.
- .5 Certification: c-UL-us Listed
- .6 Locate connection kits above grade for buried applications.

## **2.5 ACCESSORIES**

- .1 Cable Installation Accessories: Fiberglass tape, cable ties, connection kits, and end seals all furnished by manufacturer or as recommended in writing by manufacturer.
- .2 Identification: Provide and install "Electric Heat Traced" labels on exterior of pipe insulation every 10 ft. (3m) on opposite sides of pipe, and on all splices, tees, crosses, and power connections for the entire length of heat traced piping.
- .3 Thermal Pipe Insulation:
  - .1 Pipes to be thermally insulated in accordance with manufacturer's written requirements.
  - .2 Insulation shall be closed-cell in areas subject to freezing and have a flame/smoke spread rating of 25/50.

## **2.6 APPROVED MANUFACTURERS**

- .1 Approved manufacturers shall be:
  - .1 Chromalox
  - .2 Raychem
  - .3 3M
  - .4 Serge Baril
  - .5 Heron Cable Ind.
  - .6 Easy Heat (Emerson)

## **Part 3 Execution**

### **3.1 INSTALLED LOCATIONS**

- .1 Install heat trace in all areas indicated on drawings and where subject to freezing. This includes, but is not limited to:
  - .1 Water piping exposed to freezing.
  - .2 Sanitary piping exposed to freezing.

- .3 Sanitary trap exposed to freezing.
- .4 Storm piping exposed to freezing.
- .5 Rain water leader discharging to grade outside the building.
- .6 Piping placed in an outside wall.

### **3.2 EXAMINATION**

- .1 Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
  - .1 Prior to installation of heating cable system, verify that all piping, to be heat traced has passed all hydrostatic/pressure test and is signed off by plumbing inspector.
  - .2 Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
- .2 Preinstallation Testing:
  - .1 Prior to installation of heating cable on piping, an insulation resistance test shall be performed by installing contractor to ensure integrity of heating cable as describe in installation and maintenance manual.
- .3 Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.3 PREPARATION**

- .1 Protect all heating cable ends from moisture ingress until cable is terminated with end seals.
  - .1 Basis-of-Design Product: RAYCHEM; RayClic-E end seals.

### **3.4 INSTALLATION**

- .1 Install electric heating cable where indicated and in accordance with NFPA 70 and NFPA 13.
- .2 All heat-tracing components including power connections, splices, tees, and crosses or end seal, must be installed above grade and protected from abuse or damage. In accordance with NEC and CEC, electrical connections are not permitted to be installed below grade.
- .3 In the field, all heating cables shall be meggered with a minimum of 2,500 V dc for self-regulating cable. The following field megger readings shall be taken on each heating cable:
  - .1 Heating cable shall be meggered when received at Project site before installation.
  - .2 Heating cable shall be meggered after installation, but before insulation is installed.
  - .3 Heating cable shall be meggered after insulation is installed.
  - .4 Heating cable shall be meggered at final commissioning prior to being energized.
  - .5 Insulation resistance must exceed 1.000 megohms at 2,500 V dc.

- .6 All results must meet manufacturer's specification.
- .7 Test cables for electrical continuity during installation.
- .8 Test insulation integrity before energizing.
- .9 Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
- .4 Install electric heating cables after piping has passed all hydrostatic pressure testing and before insulation is installed.
- .5 Install electric heating cables in accordance with IEEE 515.1.
- .6 Install insulation over piping with electric cables.
- .7 Install warning tape on piping insulation where piping is equipped with electric heating cables.
- .8 Set field-adjustable switches and circuit-breaker trip ranges.
- .9 All heat trace cable shall be fastened to the steel pipes with plastic cable ties or fibreglass tape.
- .10 The cable shall run the entire length of each pipe linearly.
- .11 Power connection kits shall be installed in a weatherproof surface mounted junction box (suitable to house the connection kit) in the location shown on the drawings.
- .12 Provide two runs of cable along the length of piping for all piping greater than or equal to 150mm (6" diameter). Run cable along top and bottom of entire pipe length or as per manufacturer's recommendations.
- .13 **Electrical Division shall provide power to control panel only. This contractor shall be responsible for all wiring from control panel. Install wiring to standards of electrical divisions.**

### **3.5 MONITOR AND CONTROL PANEL**

- .1 Install in accordance with manufacturer's instructions.
- .2 Locate panel as indicated and mount securely. Plumb, true and square, to adjoining surfaces.
- .3 Mount panel at working height. Maintain 1m clearance in front of panel.

### **3.6 CONNECTIONS**

- .1 Ground equipment to the requirements of the Electrical Division.
- .2 Connect wiring in accordance with the requirements of the Electrical Division.
- .3 Connect heat-tracing controls to fire-alarm system in accordance with NFPA 13. Comply with requirements of the Electrical Division.

### **3.7 FIELD QUALITY CONTROL**

- .1 Manufacturer's Field Service: Initial start-up and field testing (commissioning) of system shall be performed by factory technician.
  - .1 System shall be commissioned in accordance with manufacturer's installation and operation manual.
  - .2 Field Visits to be scheduled at the following intervals:
    - .1 Preinstallation training.
    - .2 Final electrical insulation resistance (megger) testing of heating cable after insulation has been installed.
    - .3 Final commissioning including controller programming (if applicable).
  - .3 Technician to verify:
    - .1 Controller parameters are set to the application requirements.
    - .2 Controller alarm contacts are properly connected to the BMS, as applicable.
  - .4 Test cables for electrical continuity during installation.
  - .5 Test insulation integrity before energizing.
  - .6 Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
- .2 Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.
- .3 Cables will be considered defective if they do not pass tests and inspections in accordance with manufacturer's testing requirements.
- .4 Prepare test and inspection reports.

### **3.8 PROTECTION**

- .1 Protect installed heating cables, including nonheating leads, from damage and moisture ingress during construction.
- .2 Remove and replace damaged heat-tracing cables.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 Canadian General Standards Board (CGSB)
  - .1 ASTM C553, Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
  - .2 CAN/ULC-S702, Mineral Fiber Thermal Insulation for Buildings.
  - .3 ASTM C612, Mineral Fiber Block and Board Thermal Insulation.
  - .4 CGSB 51-GP-52Ma, Vapour Barrier Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .3 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
- .4 American Society for Testing and Materials (ASTM)
  - .1 ASTM C1729, Specification for Aluminum and Aluminum Alloy Sheet and Plate.
  - .2 ASTM C1393, Standard Specification for Perpendicularly Oriented Mineral Fibre Roll and Sheet Thermal Insulation for Pipes and Tanks.
  - .3 ASTM C411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
  - .4 ASTM C449, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
  - .5 ASTM C795, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
  - .6 ASTM C921, Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
  - .7 ASTM C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate-Apparatus.
  - .8 ASTM C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Apparatus.
- .5 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
  - .1 ASHRAE Standard 90.1.
- .6 Manufacturer's Trade Associations
  - .1 Thermal Insulation Association of Canada (TIAC): North American Commercial and Industrial Insulation Standard.

**1.2 PRODUCT DATA**

- .1 Submit Product Data in accordance general requirements.

### **1.3 SAMPLES SUBMITTALS**

- .1 Submit samples in accordance with general requirements.
- .2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 15 mm (1/2") plywood board. Affix typewritten label beneath sample indicating service.

### **1.4 INSTALLATION INSTRUCTIONS**

- .1 Submit properly completed detail plates from the North American Commercial and Industrial Insulation Standards Manual, applicable to installation types required by this specification section.
- .2 Submit manufacturer's installation instructions in accordance with general requirements.
- .3 Installation instructions to include procedures to be used, installation standards to be achieved.

### **1.5 QUALIFICATIONS**

- .1 Installer to have successfully completed apprenticeship program.
- .2 Installer to be specialist in performing work of this section and have at least three (3) years successful experience in this size and type of project, qualified to standards of TIAC.

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

- .1 Deliver materials to site in original factory packaging, labeled with manufacturer's name, address.
- .2 Protect from weather and construction traffic.
- .3 Protect against damage from any source.
- .4 Store at temperatures and conditions required by manufacturer.

### **1.7 DEFINITIONS**

- .1 For purposes of this section:
  - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
  - .2 "EXPOSED" - will mean "not concealed" as defined herein.
  - .3 "ASJ+" – All Service Jacket – vapor retarder laminate of aluminium foil inner layer, reinforced with fiberglass scrim, bonded to a bleached kraft paper, with outer poly film leaving no paper exposed.
  - .4 "ASJ" – All Service Jacket (no outer film) – vapor retarder laminate of aluminium foil inner layer, reinforced with fiberglass scrim, bonded to a bleached kraft paper outer layer.
  - .5 "FSK" – Foil Scrim Kraft – vapor retarder laminate of aluminium foil outer layer, reinforced with fiberglass scrim, bonded to a natural kraft paper inner layer.

- .2 Insulation systems - insulation material, fasteners, jackets, and other accessories.

## **Part 2 Products**

### **2.1 LIMITATION ON MATERIALS**

- .1 Products shall not contain formaldehyde, asbestos, lead, mercury or mercury compounds, or PBDE fire retardants.

### **2.2 FIRE AND SMOKE RATING**

- .1 In accordance with CAN/ULC S102:
  - .1 Maximum flame spread rating: 25.
  - .2 Maximum smoke developed rating: 50.

### **2.3 INSULATION**

- .1 Mineral fibre as specified herein includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C (75°F) mean temperature when tested in accordance with ASTM C177 or ASTM C518..
- .3 Type C-1: Rigid mineral fibre board, unfaced.
  - .1 Mineral fibre: to ASTM C612
  - .2 Maximum "k" factor: 0.033W/M•°C (.23BTU•IN/HR•FT²•°F)
- .4 Type A-5: Pipe to tank insulation: Fibreglass segmented board bonded to laminated vapor retarder:
  - .1 Mineral fibre: to ASTM C1393 type II or type IIIA, Category 2.
  - .2 Jacket: ASJ or FSK type
  - .3 Maximum "k" factor: 0.26 BTU • IN/HR • FT² • °F (0.037 W/M • °C) or less

### **2.4 CEMENT**

- .1 Hydraulic setting cement
  - .1 To ASTM C449
- .2 Air setting cement
  - .1 To ASTM C195
- .3 Hydraulic setting cement shall be used for all finishing work and areas where equipment is not concealed.

### **2.5 JACKETS**

- .1 Canvas:
  - .1 220 g/m² (6 oz/sq yd) cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.
  - .2 Lagging adhesive: Compatible with insulation.

## **2.6 INSULATION SECUREMENTS**

- .1 Tape: Self-adhesive, aluminum, [reinforced], 50 mm (2") wide minimum.
- .2 Contact adhesive: Quick setting.
- .3 Canvas adhesive: Washable.
- .4 Tie wire: 1.5 mm (16 gauge) diameter stainless steel.
- .5 Bands: Stainless steel, 20 mm (3/4") wide, 0.5 mm (0.020") thick.
- .6 Facing: 25 mm (1") galvanized steel hexagonal wire mesh on one face of insulation.
- .7 Fasteners: 4 mm (5/32") diameter pins with 40 mm (1½") clips. Length of pin to suit thickness of insulation. Types of pins to be CD weld, self-adhesive or glue-applied – to be selected and confirmed with consultant in accordance with required service conditions.

## **2.7 VAPOUR RETARDER LAP ADHESIVE**

- .1 Water based, fire retardant type, compatible with insulation.

## **2.8 INDOOR VAPOUR RETARDER FINISH**

- .1 Compatible with insulation.

## **2.9 OUTDOOR VAPOUR RETARDER MASTIC**

- .1 Compatible with insulation.
- .2 Reinforcing fabric: Open weave fibreglass fabric with maximum weave of 10 x 10 squares per inch.

## **Part 3 Execution**

### **3.1 PRE-INSTALLATION REQUIREMENTS**

- .1 Pressure testing of equipment and adjacent piping systems to be complete, witnessed and certified.
- .2 Surfaces to be clean, dry, free from foreign material.

### **3.2 INSTALLATION**

- .1 Install in accordance with TIAC North American Commercial and Industrial Insulation Standards.
  - .1 Hot equipment: To TIAC code 1503-H.
  - .2 Cold equipment: to TIAC code 1503-C.
- .2 Elastomeric Insulation: to remain dry at all times. Overlaps to be to manufacturer instructions. Joints to be tight and sealed properly.



- .3 Below ambient/chilled water installation:
  - .1 All pipes, fittings, valves, strainers, flanges, unions, and other pipe system components and specialties must be properly insulated with correctly completed vapor retarded applied.
  - .2 All insulation material must have properly installed and sealed vapor retarding jacket, including circumferential and longitudinal seams.
  - .3 All penetrations, tears, and punctures must be repaired and sealed with a vapor retarding material with a .02 or lower perm rating.
  - .4 Vapor stops must be installed at 18' intervals, at all pipe insulation termination points, including fittings, flanges, and other changes in direction or other types of piping specialties.
  - .5 All fitting insulation must be of the same type, thickness, and density of the pipe insulation, be premoulded insulation covers or fabricated from the same material as the pipe insulation. Full thickness must be factory-applied, vapor-retarder facing is unacceptable.
  - .6 A complete vapor retarder must be installed on insulation over fittings before applying final finish. Vapor retarder must extend onto and be sealed to the vapor retarder or pipe insulation.
  - .7 Additional fitting covers, PVC or metal, must have a vapor retarder seal applied to all longitudinal and circumferential seams in addition to the vapor retarder applied to the fitting insulation.
  - .8 Additional field applied jackets must not use staples, screws, tacks or rivets for attachment, to avoid puncturing vapor retarder underneath.
  - .9 Insulating support inserts are to be high compressive strength insulation with a rigid shield. No calcium silicate is to be used for insulation on below-ambient operation piping.
- .4 Provide vapour retarder as recommended by manufacturer.
- .5 Apply materials in accordance with insulation and equipment manufacturers instructions and this specification.
- .6 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm (3").
- .7 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1 Hangers, supports to be outside vapour retarder jacket.
- .8 Supports, Hangers:
  - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

### **3.3 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES**

- .1 Flexible removable blanket insulation covers are not acceptable for below-ambient (cold) operation equipment. Rigid removable insulation jackets that are vapor retarder exterior material, that can be vapor sealed at the seams, are acceptable on below ambient (cold) operation system.

- .2 Application: At expansion joints, valves, primary flow measuring elements flanges and unions at equipment.
- .3 Installation to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation. Fabricate flexible, removable insulation in accordance with ASTM C1695 Standard Specification for Fabrication of Flexible Removable and Reusable Blanket Insulation for Hot Service.

### 3.4 EQUIPMENT INSULATION SCHEDULES

- .1 Includes valves, valve bonnets, strainers, flanges, and fittings unless otherwise specified.
- .2 Hot Equipment:
  - .1 Type A-5 or C-1 with mechanical fastenings and bands and 15 mm ( $\frac{1}{2}$ ") cement reinforced with one layer of reinforcing mesh.
  - .2 Type and Thickness:

ITEM	THICKNESS	TYPE
Domestic hot water storage tanks	25 mm (1")	A-5 or C-1
Heat exchangers	50 mm (2")	A-5 or C-1

- .3 Finishes/Jackets:
  - .1 Equipment in mechanical rooms: TIAC code CEF/1 with canvas jacket.
  - .2 Equipment elsewhere: TIAC code CEF/2 with 15mm ( $\frac{1}{2}$ ") cement canvas jacket.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 Canadian General Standards Board (CGSB)
  - .1 ASTM C553, Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
  - .2 CGSB 51-GP-52Ma, Vapour Barrier Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
  - .3 CAN/CGSB-51.53, Poly (Vinyl Chloride) Jacketing Sheet, for Insulating Pipes, Vessels and Round Ducts.
- .3 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC-S102, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
- .4 American Society for Testing and Materials (ASTM)
  - .1 ASTM C547, Type I and IV, Standard Specifications for Mineral Fibre Pipe Insulation.
  - .2 ASTM C 335, Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
  - .3 ASTM C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot-Plate Apparatus.
  - .4 ASTM C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
  - .5 ASTM C 921, Practice for Determining the Properties Jacketing Materials for Thermal Insulation.
  - .6 ASTM C1695, Standard Specification for Fabrication of Flexible, Removable, and Reusable Blanket Insulation for Hot Service.
  - .7 ASTM C1729 Standard Specification for Aluminium Jacketing for Insulation.
  - .8 **ASTM C 411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.**
  - .9 **ASTM C 449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.**
  - .10 **ASTM C 795, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.**
- .5 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).
  - .1 ASHRAE Standard 90.1.

- .6 Manufacturer's Trade Associations
  - .1 Thermal Insulation Association of Canada (TIAC), North American Commercial and Industrial Insulation Standards.

## **1.2 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with general requirements.
- .2 Submit for approval manufacturer's catalogue literature related to installation, fabrication for pipe, fittings, valves, and jointing recommendations.
- .3 Submit properly completed detail plates from the North American Commercial and Industrial Insulation Standards manual, applicable to installation types required by this specific section.

## **1.3 INSTALLATION INSTRUCTIONS**

- .1 Submit manufacturer's installation instructions in accordance with general requirements.
- .2 Installation instructions to include procedures to be used, installation standards to be achieved.

## **1.4 QUALIFICATIONS**

- .1 Installer to have successfully completed apprenticeship program.
- .2 Installer to be specialist in performing work of this section and have at least three (3) years successful experience in this size and type of project, qualified to standards of TIAC.

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

- .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Protect from weather, construction traffic.
- .3 Protect against damage from any source.
- .4 Store at temperatures and conditions required by manufacturer.

## **1.6 DEFINITIONS**

- .1 For purposes of this section:
  - .1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
  - .2 "EXPOSED" - will mean "not concealed" as defined herein.
  - .3 "ASJ+" – All Service Jacket – vapor retarder laminate of aluminium foil inner layer, reinforced with fiberglass scrim, bonded to a bleached kraft paper, with outer poly film leaving no paper exposed.
  - .4 "ASJ" – All Service Jacket (no outer film) – vapor retarder laminate of aluminium foil inner layer, reinforced with fiberglass scrim, bonded to a bleached kraft paper outer layer.

---

**Part 2            Products**

**2.1            MATERIAL LIMITATIONS**

- .1        Products shall not contain formaldehyde, asbestos, lead, mercury or mercury compounds or PBDE fire retardants.

**2.2            FIRE AND SMOKE RATING**

- .1        In accordance with CAN/ULC-S102:
  - .1        Maximum flame spread rating: 25.
  - .2        Maximum smoke developed rating: 50.

**2.3            INSULATION**

- .1        Mineral fibre as specified herein includes glass fibre, rock wool, slag wool.
- .2        Thermal conductivity ("k" factor) not to exceed specified values at 24°C (75°F) mean temperature when tested in accordance with ASTM C335, ASTM C177 or ASTM C518.
- .3        Type A-1: Rigid moulded or wound mineral fibre with factory applied vapour retarder jacket.
  - .1        Mineral fibre: to ASTM C547 Type I and IV.
  - .2        Jacket: to ASTM C1136, Type I, II, III, IV, X.
  - .3        Maximum "k" factor: to ASTM C547.
- .4        Type A-2: Mineral fibre faced with factory applied vapour retarder jacket.
  - .1        Mineral fibre: to ASTM C553.
  - .2        Jacket: to CGSB 51-GP-52 Ma.
  - .3        Maximum "k" factor: to ASTM C553.
- .5        Materials:
  - .1        All materials must be supplied by the same manufacturer.
  - .2        Acceptable Materials:
    - .1        Johns Manville
    - .2        Knauf
    - .3        Manson
    - .4        Owens Corning

**2.4            INSULATION SECUREMENT**

- .1        Tape: Self-adhesive, aluminum, reinforced, 50 mm (2") wide minimum.
- .2        Contact adhesive: Quick setting.
- .3        Canvas adhesive: Washable.

**2.5            CEMENT**

- .1        Thermal insulating and finishing cement:
  - .1        Hydraulic setting or Air drying on mineral wool, to ASTM C 449M.

## **2.6 VAPOUR RETARDER LAP ADHESIVE**

- .1 Water based, fire retardant type, compatible with insulation.

## **2.7 INDOOR VAPOUR RETARDER FINISH**

- .1 Compatible with insulation.

## **2.8 JACKETS**

- .1 Polyvinyl Chloride (PVC):
  - .1 Minimum thickness: 20 mm (0.020")
  - .2 One-piece moulded type [and sheet] to CAN/CGSB-51.53 with pre-formed shapes as required.
  - .3 Colours: white.
  - .4 Minimum service temperatures: -29°C (-20°F).
  - .5 Maximum service temperature: 65°C (150°F).
  - .6 Moisture vapour transmission: 0.05 perm.
  - .7 Fastenings:
    - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
    - .2 Tacks are not to be used below ambient temperature (cold) operating systems.
    - .3 Pressure sensitive vinyl tape of matching colour.
- .2 Aluminum:
  - .1 To ASTM C 1729
  - .2 Thickness: 0.50 mm (0.020") sheet.
  - .3 Finish: Smooth.
  - .4 Joining: Longitudinal and circumferential slip joints with 50 mm (2") laps.
  - .5 Fittings: 0.50 mm (0.020") thick die-shaped fitting covers with factory-attached protective liner.
  - .6 Metal jacket banding and mechanical seals: stainless steel, 20 mm (3/4") wide, 0.50 mm (0.020") thick at 300 mm (12") spacing.

## **2.9 CAULKING FOR JACKETS**

- .1 Caulking: Silicone clear caulking.

## **Part 3 Execution**

### **3.1 PRE-INSTALLATION REQUIREMENT**

- .1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed, and certified.
- .2 Surfaces to be clean, dry, free from foreign material.

### **3.2 INSTALLATION**

- .1 Install in accordance with TIAC, North American Commercial and Industrial Insulation Standards.
- .2 Apply materials in accordance with manufacturers' instructions and this specification.
- .3 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1 Hangers, supports to be outside vapour retarder jacket.
- .4 Supports, Hangers:
  - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.
- .5 Below ambient/chilled water installation:
  - .1 All pipes, valves, strainers, flanges, unions, and other pipe system components and spec must be properly insulated with correctly completed vapor retarder applied.
  - .2 All insulation material must have properly installed and sealed vapor retarding jacket, including circumferential and longitudinal seams.
  - .3 All penetrations, tears, and punctures must be repaired and sealed with a vapor retarding material with a 0.02 or lower perm rating.
  - .4 Vapor stops must be installed at 18' intervals at all pipe insulation termination points including fittings, flanges, and other changes in direction or other types of piping specialties.
  - .5 All fitting insulation must be of the same type, thickness, and density of the pipe insulation, be premoulded insulation covers or fabricate from the same material as the pipe insulation. Full thickness must be maintained over all fitting surfaces. Blanket insulation with a factory applied vapor retarder facing is unacceptable.
  - .6 A complete vapor retarder must be installed on insulation over fittings before applying final finish. Vapor retarder must extend onto and be sealed to the vapor retarder of the pipe insulation.
  - .7 Additional fitting covers, PVC, or metal must have a vapor retarder seal applied to all longitudinal and circumferential seams in addition to the vapor retarder applied to the fitting insulation.
  - .8 Additional field applied to jackets must not use staples, screws, tacks, or rivets for attachment to avoid puncturing vapor retarder underneath.
  - .9 Insulating support inserts are to be high compressive strength insulation with a rigid shield. No calcium silicate is to be used for insulation on below-ambient operation piping.

### **3.3 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES**

- .1 Application: At expansion joints, valves, primary flow measuring elements, flanges, and unions at equipment.

- .2 Flexible removable blanket insulation covers are not acceptable for below-ambient (cold) operation piping systems. Rigid removable insulation jackets that are vapor retarder exterior material, that can be vapor sealed at the seams, are acceptable on below-ambient (cold) operation piping systems.
- .3 Design: To permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.
- .4 Insulation:
  - .1 Insulation, fastenings and finishes: same as system.
  - .2 Jacket: As per adjacent insulation.

### 3.4 INSTALLATION OF ELASTOMERIC INSULATION

- .1 Insulation to remain dry at all times. Overlaps to manufacturers instructions. Ensure tight joints.
- .2 Provide vapour retarder as recommended by manufacturer.

### 3.5 PIPING INSULATION SCHEDULES

- .1 Includes valves, valve bonnets, strainers, flanges, and fittings unless otherwise specified.
- .2 Install insulator and jackets to applicable TIAC codes.
- .3 Insulate ends of capped piping with type and thickness indicated for capped service.
- .4 Thickness of insulation to be as listed in following table:
  - .1 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.
  - .2 All storm piping including all vertical and horizontal piping shall be insulated.

Application	Type	Pipe sizes through (NPS) and insulation thickness mm (")				
		to 25 (1")	32 (1¼") 40 (1½")	50 (2") 80 (3")	105 (4") 150 (6")	200 (8") & over
Domestic Water Piping	A-1	25 (1")	25 (1")	40 (1½")	40 (1½")	40 (1½")
Storm Piping	A-1	25 (1")	25 (1")	25 (1")	25 (1")	25 (1")
Cooling Coil cond. Drain	A-1	25 (1")	25 (1")	25 (1")	25 (1")	25 (1")
Roof Drain sumps	A-2	25 (1")	25 (1")	25 (1")	25 (1")	25 (1")
Horizontal Cast Iron	A-1	N/A	N/A	25 (1")	25 (1")	25 (1")
Sanitary Piping						
Trap Primer Piping	A-1	15 (½")	15 (½")	25 (1")		



- .5 Finishes: Conform to the following table:

<u>Application</u>	<u>Piping</u>	<u>Valves &amp; Fittings</u>
Exposed indoors	PVC	PVC
Exposed in mech. rooms	PVC	PVC
Concealed indoors	N/A	PVC
Outdoors	Aluminum	Aluminum

- .6 Connection: To appropriate TIAC code.
- .7 Finish attachments: SS bands, @ 150 mm (6") oc. seals: closed.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ANSI/AWWA B301, Liquid Chlorine.
- .3 ANSI/AWWA C104/A21.4, Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water.
- .4 ANSI/AWWA C205, Cement Mortar Protective Lining and Coating for Steel Water Pipe - 4 inch and larger - Shop Applied.
- .5 ANSI/AWWA C207, Steel Pipe Flanges for Waterworks Service, 4 inch through 144 inch.
- .6 ANSI/AWWA C500, Metal-seated Gate Valves for Water Supply Service.
- .7 ANSI/AWWA C600, Installation of Ductile Iron Water Mains, and their Appurtenances.
- .8 ANSI/AWWA C800, Underground Service Line Valves and Fittings.

**1.2            SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with general division.

**1.3            AS-BUILT DRAWINGS**

- .1 Provide Data to produce as-built drawings, including directions for operating valves, list of equipment required to operate valves, details of pipe material, location of air and vacuum release valves, hydrant details, maintenance and operating instructions in accordance with Submittals Section.

**1.4            SCHEDULING OF WORK**

- .1 Schedule work to minimize interruptions to existing services. Interruptions during school hours will not be allowed.
- .2 Submit schedule of expected interruptions to Consultant for approval and adhere to interruption schedule as approved by Consultant.
- .3 Notify building occupants' minimum of 24 h in advance of any interruption in service.
- .4 Do not interrupt water service for more than 3 h and confine this period between 16:00 and 6:00 h local time or weekends unless otherwise authorized.
- .5 Notify fire department of any planned or accidental interruption of water supply to hydrants.
- .6 Advise local police department of anticipated interference with movement of traffic.
- .7 Notify owner's security company with any interruptions.

## **Part 2 Products**

### **2.1 PIPES, JOINTS AND FITTINGS**

- .1 Ductile iron pipe: to ANSI/AWWA C151/A21.51, class 52 cement mortar lined to ANSI/AWWA C104/A21.4.
  - .1 Acceptable material: HYPROTEC
- .2 P.V.C. pipe: to AWWA C900, CSA B137.2, ASTM, class 150 P.V.C. (DR18).
  - .1 Acceptable material: Blue Brute or Equal.
- .3 Joints and fittings for ductile iron pipe:
  - .1 Joints:
    - .1 Rubber gasket for mechanical pipe joints: to ANSI/AWWA C111/A21.11.
    - .2 Rubber gasket for flange pipe joints 1.6 mm thick: to ANSI/AWWA C111/A21.11.
    - .3 Bolts, nuts, hex head with washers: to ASTM A307, heavy series.
    - .4 Ensure electrical conductivity across joints.
  - .2 Fittings:
    - .1 Mechanical joint cast iron and ductile iron fittings NPS 3 and larger: to ANSI/AWWA C110/A21.10.
    - .2 Flanged cast iron fittings NPS 3 and larger: to ANSI/AWWA C110/A21.10.

### **2.2 FITTINGS AND SPECIALTIES**

- .1 All fittings and specials shall be installed where shown or where ordered by the Engineer. Fittings subject to lateral thrust or “blow-out” shall be properly supported by cast-in-place thrust blocks of 25 Mpa concrete placed against undisturbed earth in accordance with the contract drawings. Where necessary, when working in unstable ground conditions or when installing vertical bends, the contractor shall use anchor blocks with anchor rods, or tie rods connected to the closest solid joint, to assure proper support against “blow-out”.

### **2.3 PIPE BEDDING AND SURROUND MATERIAL**

- .1 Granular material to Aggregates: General and following requirements:
  - .1 Crushed or screened stone, gravel or sand.
  - .2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117 Sieve sizes to CAN/CGSB-8.1.
- .2 Concrete mixes and materials required for bedding cradles, encasement, supports, thrust blocks: to Cast-in-Place Concrete Section.

### **2.4 BACKFILL MATERIAL**

- .1 As indicated.
- .2 Type 3, in accordance with Excavating, Trenching and Backfilling.

## **2.5 PIPE DISINFECTION**

- .1 Liquid chlorine to ANSI/AWWA B301 to disinfect water mains.

## **Part 3 Execution**

### **3.1 PREPARATION**

- .1 Clean pipes, fittings, valves, hydrants, and appurtenances of accumulated debris and water before installation. Carefully inspect materials for defects. Remove defective materials from site.

### **3.2 TRENCHING**

- .1 Do trenching work in accordance with Excavating Trenching and Backfilling Section.
- .2 Trench depth to provide cover over pipe of not less than 1.85 m from finished grade.

### **3.3 GRANULAR BEDDING**

- .1 Place granular bedding material in uniform layers not exceeding 150 mm compacted thickness to depth of 150 mm below bottom of pipe to depth as indicated.
- .2 Do not place material in frozen condition.
- .3 Shape bed true to grade to provide continuous uniform bearing surface for pipe.
- .4 Shape transverse depressions in bedding as required to suit joints.
- .5 Compact each layer full width of bed to at least 95% of corrected maximum dry density and 95% maximum density to ASTM D698.
- .6 Fill authorized or unauthorized excavation below design elevation of bottom of specified bedding in accordance with Excavating Trenching and Backfilling Section.

### **3.4 PIPE INSTALLATION**

- .1 **Connect to domestic water and fire main piping installed by site services contractor.** Terminate building water service inside building and 450 mm above finish floor. Install coupling necessary for connection to building plumbing. If plumbing is already installed, make connection; otherwise cap or seal end of pipe.
- .2 Lay pipes to ANSI/AWWA C600 and ANSI/AWWA Manual of Practice and manufacturer's standard instructions and specifications. Do not use blocks.
- .3 Join pipes in accordance with ANSI/AWWA C600 ANSI/AWWA C602 ANSI/AWWA C206 AWWA Manual of Practice and manufacturer's recommendations.
- .4 Handle pipe by methods recommended by pipe manufacturer. Do not use chains or cables passed through pipe bore so that weight of pipe bears on pipe ends.
- .5 Lay pipes on prepared bed, true to line and grade. Ensure barrel of each pipe is in contact with shaped bed throughout its full length. Take up and replace defective pipe. Correct pipe, which is not in true alignment or grade or pipe, which shows differential settlement after installation greater than 10 mm.

- .6 Face socket ends of pipe in direction of laying. For mains on a grade of 2% or greater, face socket ends up-grade.
- .7 Do not exceed permissible deflection at joints as recommended by pipe manufacturer.
- .8 Keep jointing materials and installed pipe free of dirt and water and other foreign materials. Whenever work is stopped, install a removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
- .9 Position and join pipes with equipment and methods approved by Consultant.
- .10 Cut pipes in an approved manner as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.
- .11 Align pipes carefully before jointing.
- .12 Install gaskets to manufacturer's recommendations. Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.
- .13 Avoid displacing gasket or contaminating with dirt or other foreign material. Gaskets so disturbed or contaminated shall be removed, cleaned, lubricated and replaced before jointing is attempted again.
- .14 Complete each joint before laying next length of pipe.
- .15 Minimize deflection after joint has been made.
- .16 Apply sufficient pressure in making joints to ensure that joint is completed to manufacturer's recommendations.
- .17 Ensure completed joints are restrained by compacting bedding material alongside and over installed pipes or as otherwise approved by Engineer.
- .18 When stoppage of work occurs, block pipes in an approved manner to prevent creep during down time.
- .19 Recheck plastic pipe joints assembled above ground after placing in trench to ensure that no movement of joint has taken place.
- .20 Do not lay pipe on frozen bedding.
- .21 Do hydrostatic and leakage test and have results approved by Consultant before surrounding and covering joints and fittings with granular material.
- .22 Backfill remainder of trench.

### **3.5 THRUST BLOCKS**

- .1 Install thrust blocks to OPS standards for roads and municipal services.
- .2 Concrete shall be placed to within 50 mm of the face of the bell.
- .3 Bond breaker shall be used between the fittings and concrete.

### **3.6 HYDROSTATIC AND LEAKAGE TESTING**

- .1 Provide labour, equipment and materials required to perform hydrostatic and leakage tests hereinafter described.

- .2 Notify Consultant at least 24 h in advance of all proposed tests. Perform tests in presence of Consultant.
- .3 Where any section of system is provided with concrete thrust blocks, conduct tests at least 5 days after placing concrete or 2 days if high early strength concrete is used.
- .4 Upon completion of pipe laying and after Consultant has inspected work in place, surround and cover pipes between joints with approved granular material placed to dimensions indicated or directed by Consultant.
- .5 Leave hydrants, valves, joints and fittings exposed.
- .6 Strut and brace caps, bends, tees, and valves, to prevent movement when test pressure is applied.
- .7 Open valves.
- .8 Expel air from main by slowly filling main with potable water. Install corporation stops at high points in main where no air-vacuum release valves are installed. Remove stops after satisfactory completion of test and seal holes with plugs.
- .9 Thoroughly examine exposed parts and correct for leakage as necessary.
- .10 Examine exposed pipe, joints, fittings and appurtenances while system is under pressure.
- .11 Remove joints, fittings and appurtenances found defective and replace with new sound material and make watertight.
- .12 Do not exceed allowable leakage of 0.03 L/mm diameter per 300 m of pipe, including lateral connections, per hour.
- .13 Locate and repair defects if leakage is greater than amount specified.
- .14 Repeat test until leakage is within specified allowance for full length of watermain.

### **3.7 PIPE SURROUND**

- .1 Upon completion of pipe laying and after Consultant has inspected work in place, surround and cover pipes as indicated.
- .2 Hand place surround material in uniform layers not exceeding 150 mm compacted thickness as indicated.
- .3 Place layers uniformly and simultaneously on each side of pipe.
- .4 Do not place material in frozen condition.
- .5 Compact each layer from pipe invert to mid height of pipe to at least 95% of corrected maximum dry density.
- .6 Compact each layer from mid height of pipe to underside of backfill to at least 90% of corrected maximum dry density.

### **3.8 BACKFILL**

- .1 Place backfill material, above pipe surround, in uniform layers not exceeding 150 mm compacted thickness up to grades as indicated.

- .2 Do not place backfill in frozen condition.
- .3 Under paving and walks, compact backfill to at least 95% corrected maximum dry density. In other areas, compact to at least 90% corrected maximum dry density.

### **3.9 FLUSHING AND DISINFECTING**

- .1 Flush water mains through available outlets with a sufficient flow of potable water to produce a velocity of 1.5 m/s, within pipe for 10 min, or until foreign materials have been removed and flushed water is clear with backflow protection.
- .2 Flushing flows shall be as follows:

<u>Pipe Size NPS</u>	<u>Flow (L/s) Minimum</u>
6 and below	38
8	75
10	115
<u>12</u>	<u>150</u>
- .3 Provide connections and pumps for flushing as required.
- .4 Open and close valves, hydrants and service connections to ensure thorough flushing.
- .5 When flushing has been completed to satisfaction of Consultant, introduce a strong solution of chlorine as approved by authority having jurisdiction into watermain and ensure that it is distributed throughout entire system.
- .6 Rate of chlorine application to be proportional to rate of water entering pipe.
- .7 Chlorine application to be close to point of filling water main and to occur at same time.
- .8 Operate valves, hydrants and appurtenances while main contains chlorine solution.
- .9 Flush line to remove chlorine solution after 24 h.
- .10 Measure chlorine residuals at extreme end of pipe-line being tested.
- .11 Perform bacteriological tests on water main, after chlorine solution has been flushed out. Take samples daily for minimum of two days. Should contamination remain or recur during this period, repeat disinfecting procedure. Specialist contractor shall submit certified copy of test results.
- .12 Take water samples at hydrants and service connections, in suitable sequence, to test for chlorine residual.
- .13 After adequate chlorine residual not less than 50 ppm has been obtained leave system charged with chlorine solution for 24 h. After 24 h, further samples shall be taken to ensure that there is still not less than 10 ppm of chlorine residual remaining throughout system.

### **3.10 SURFACE RESTORATION**

- .1 After installing and backfilling over water mains, restore surface including all roads, curbs, sidewalks, landscaped areas etc. to original condition and to standards of local authority having jurisdiction.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ANSI/ASME B16.15, Cast Copper Alloy Threaded Fittings, Classes 125 and 250.
- .3 ANSI B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
- .4 ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- .5 ANSI B16.24, Cast Copper Alloy, Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500.
- .6 ASTM B88M, Specification for Seamless Copper Water Tube (Metric).
- .7 MSS-SP-70, Cast Iron Gate Valves, Flanged and Threaded Ends.
- .8 MSS-SP-71, Cast Iron Swing Check Valves, Flanged and Threaded Ends.
- .9 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.
- .10 ANSI/AWWA C111/A21.11, Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .11 ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
- .12 ASTM F1545, Specification for Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges.
- .13 CSA B242, Groove and Shoulder Type Mechanical Pipe Couplings.
- .14 MSS-SP-67, Butterfly Valves.

**1.2 SHOP DRAWINGS**

- .1 Submit shop drawing data in accordance with general requirements.

**1.3 MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.

**Part 2 Products**

**2.1 PIPING**

- .1 Domestic hot, cold and recirculation systems, within building.
  - .1 Above ground: copper tube, hard drawn, type L: to ASTM B88M.

**2.2 FITTINGS**

- .1 Bronze pipe flanges and flanged fittings, Class 150 and 300: to ANSI B16.24.
- .2 Cast bronze threaded fittings, Class 125 and 250: to ANSI/ASME B16.15.
- .3 Cast copper, solder type: to ANSI B16.18.



- .4 Wrought copper and copper alloy, solder type: to ANSI/ASME B16.22.
- .5 Tee drill NPS 25 mm (1") and larger.
- .6 NPS 80 mm (3") and larger: roll grooved to CSA B242.

## **2.3 JOINTS**

- .1 Solder: 95/5.
- .2 Teflon tape: for threaded joints.
- .3 Dielectric connections between dissimilar metals: dielectric fitting to ASTM F1545, complete with thermoplastic liner.
- .4 Tee drill fittings shall be brazed with silver solder, 45% Ag - 15% Cu or copper phosphorous, 95% Cu, 5% P and non-corrosive flux.
- .5 Rubber gaskets, 1.5 mm (16 gauge) thick: to ANSI/AWWA C111/A21.11.
- .6 Bolts, nuts, hex head and washers: to ASTM A307, heavy series.
- .7 Grooved couplings: designed with angle bolt pads to provide rigid joint, complete with EPDM flush seal gasket.

## **2.4 VALVES**

- .1 All valves shall be of commercial grade and of same manufacturer, Lead-Free.
- .2 Acceptable materials:
  - .1 Milwaukee
  - .2 Crane
  - .3 Kitz
  - .4 Apollo

## **2.5 BALL VALVES**

- .1 All valves shall be of commercial grade and of same manufacturer.
- .2 NPS 80 mm (3") and under, soldered:
  - .1 To ANSI B16.18, Class 150.
  - .2 Bronze body, full port stainless steel ball, PTFE Teflon adjustable packing, brass gland and PTFE Teflon seat, steel lever handle, with NPT to copper adaptors.

## **2.6 GATE VALVES**

- .1 NPS 50 mm (2") and under, soldered:
  - .1 Rising stem: to MSS SP-80, Class 125, 860 kPa (125 psi), bronze body, screw-in bonnet, solid wedge disc.
- .2 NPS 50 mm (2") and under, screwed:
  - .1 Rising stem: to MSS SP-80, Class 125, 860 kPa (125 psi), bronze body, screw-in bonnet, solid wedge disc.

- .3 NPS 65 mm (2-1/2") and over, in mechanical rooms, flanged:
  - .1 Rising stem: to MSS SP-70, Class 125, 860 kPa (125 psi), flat flange faces, cast-iron body, OS&Y bronze trim.
- .4 NPS 65 mm (2-1/2") and over, other than mechanical rooms, flanged:
  - .1 Non-rising stem: to MSS SP-70, Class 125, 860 kPa (125 psi), flat flange faces, cast-iron body, bronze trim, bolted bonnet.

## **2.7 GLOBE VALVES**

- .1 NPS 50 mm (2") and under, soldered:
  - .1 To MSS SP-80, Class 125, 860 kPa (125 psi), bronze body, renewable composition disc, screwed over bonnet.
  - .2 Lockshield handles: as indicated.
- .2 NPS 50 mm (2") and under, screwed:
  - .1 To MSS SP-80, Class 150, 1.03 MPa (150 psi), bronze body, screwed over bonnet, renewable composition disc.
  - .2 Lockshield handles: as indicated.

## **2.8 SWING CHECK VALVES**

- .1 NPS 50 mm (2") and under, soldered:
  - .1 To MSS SP-80, Class 125, 860 kPa (125 psi), bronze body, bronze swing disc, screw in cap, regrindable seat.
- .2 NPS 50 mm (2") and under, screwed:
  - .1 To MSS SP-80, Class 125, 860 kPa (125 psi), bronze body, bronze swing disc, screw in cap, regrindable seat.
- .3 NPS 65 mm (2 1/2") and over, flanged:
  - .1 To MSS SP-71, Class 125, 860 kPa (125 psi), cast iron body, flat flange faces, [regrind] [renewable] seat, bronze disc, bolted cap.

## **2.9 BUTTERFLY VALVES**

- .1 Provide copper tubing grooved valves where indicated.
- .2 NPS 100 mm (4") and over:
  - .1 Bronze body per CDA-836.
  - .2 EPDM/Bronze disk and trim.
  - .3 Two position handle.
- .3 Acceptable material:
  - .1 Victaulic Series 608

## **2.10 BALANCING VALVES**

- .1 Provide brass balancing valves suitable for potable water.

- .2 Brass body, EDPM O-Ring, Polytetrafluoroethylene slip washer and stainless steel spring.
- .3 Connect with dielectric connections.

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 Install in accordance with Provincial Plumbing Code and local authority having jurisdiction.
- .2 Cut square, ream and clean tubing and tube ends, clean recesses of fittings and assemble without binding.
- .3 Assemble all piping using fittings manufactured to ANSI standards.
- .4 Install tubing close to building structure to minimize furring, conserve headroom and space. Group exposed piping and run parallel to walls.
- .5 Install CWS piping below and away from HWS and HWC and all other hot piping so as to maintain temperature of cold water as low as possible.
- .6 Connect to fixtures and equipment in accordance with manufacturers instructions unless otherwise indicated.
- .7 Bent tubing is not acceptable.

#### **3.2 VALVES**

- .1 Isolate equipment, fixtures and branches with ball valves.
- .2 Balance recirculation system using lockshield globe valves. Mark settings and record on as-built drawings on completion.

#### **3.3 PRESSURE TESTS**

- .1 Conform to requirements of general requirements.
- .2 Test pressure: greater of 1½ times maximum system operating pressure or 860 kPa (125 psi).

#### **3.4 FLUSHING AND DISINFECTING**

- .1 Maintain testable RP backflow preventor between municipal water and new plumbing system.
- .2 Ensure a minimum of 90% of plumbing fixtures are installed.
- .3 Flush water mains through available outlets with a sufficient flow of potable water to produce a velocity of 1.5 m/s, within pipe for 10 min, or until foreign materials have been removed and flushed water is clear with backflow protection.
- .4 Provide connections and pumps for flushing as required.
- .5 Open and close valves, and operate fixtures to ensure thorough flushing.

- 
- .6 When flushing has been complete to satisfaction of Consultant introduce a strong solution of Chlorine into water system and ensure that it is distributed throughout entire system.
  - .7 Rate of chlorine application to be proportional to rate of water entering pipe.
  - .8 Chlorine injection to be close to point of filling water main or at building water service and to occur simultaneously.
  - .9 Confirm adequate chlorine residual not less than 50 ppm has been obtained, leave system charged with chlorine solution for 24 h. After 24 h, further samples shall be taken to ensure that there is still not less than 10 ppm of chlorine residual remaining throughout system.
  - .10 Upon 10 ppm confirmation and 24 hr elapsed time flush line to remove chlorine solution.
  - .11 Measure chlorine residuals at extreme end of pipe-line being tested.
  - .12 Perform bacteriological tests on water main, after chlorine solution has been flushed out. Take samples daily for minimum of two days. Should contamination remain or reoccur during this period, repeat disinfecting procedure. Specialist contractor shall submit certified copy of test results.
  - .13 Take water samples at remote fixtures and service connections.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 CAN/CSA – B64.10/B64.10.1 – Selection and Installation of Backflow Preventers/Maintenance and Field Testing of Backflow Preventers.

**1.2            SUBMITTALS**

- .1 Complete the required cross connection survey form and submit to authority having jurisdiction. Provide a copy to the consultant.
- .2 Incorporate data into maintenance manual.

**Part 2            Products**

**2.1            GENERAL**

- .1 Provide backflow prevention devices in all new and existing fixtures and equipment as indicated and as required by the authority having jurisdiction.
- .2 Acceptable materials:  
Watts  
Wilkins

**Part 3            Execution**

**3.1            INSTALLATION**

- .1 Install devices in accordance with acceptable engineering practices, the requirements of the Ontario Building Code and the requirements of the authority having jurisdiction.

**3.2            TESTING**

- .1 Provide testing to requirements of authority having jurisdiction.
- .2 Provide copy of test report for each device in the maintenance manual.
- .3 Provide tag on each device.
- .4 Provide a list of devices complete with tag number on a framed chart. Locate chart in Water Entrance Room.
- .5 Provide additional testing on all devices at one year warranty period. Provide documentation to owner and consultant.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ASTM A126, Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
- .3 ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
- .4 PDI-WH201, Water Hammer Arresters.
- .5 CAN/CSA-B64 Series, Backflow Preventers and Vacuum Breakers.
- .6 **ANSI/AWWA C700, Cold Water Meters-Displacement Type, Bronze Main Case.**
- .7 **ANSI/AWWA C701, Cold Water Meters-Turbine Type, for Customer Service.**
- .8 **ANSI/AWWA C702, Cold Water Meters-Compound Type.**
- .9 **CSA-B356, Water Pressure Reducing Valves for Domestic Water Supply Systems.**

**1.2                SUBMITTALS**

- .1 Submit shop drawings and product data in accordance with general requirements.
- .2 For shop drawings, indicate dimensions, construction details and materials.
- .3 For product data, indicate dimensions, construction details and materials for all items specified herein.

**1.3                MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.
- .2 Data to include:
  - .1 Description of plumbing specialties and accessories, giving manufacturers name, type, model, year and capacity.
  - .2 Details of operation, servicing and maintenance.
  - .3 Recommended spare parts list.

**Part 2            Products**

**2.1                NON-FREEZE WALL HYDRANTS (SURFACE, EXPOSED)(HB-1)**

- .1 Surface mount, exposed, all bronze construction, anti-syphon, non freeze wall hydrant with non-turning operating rod, free floating compression valve, integral vacuum breaker, self draining, replaceable seat and seat washer. Stainless steel or chrome plated face with operating key lock. NPS 20 mm (¾") hose outlet.

- .2 Acceptable materials:
  - .1 Zurn Z-1310
  - .2 Mifab MHY-10
  - .3 Watts HY-420
  - .4 Jay R. Smith 5509QT-NB

## **2.2 INTERIOR HOSE BIBB (HB-2)**

- .1 20 mm (3/4") diameter brass construction, 200 psi, 180°F pressure and temperature limits, complete with hose connection, and wheel handle straight/angle pattern to suit.
- .2 Provide vacuum breaker complete with hose connection.
- .3 Acceptable manufacturers:
  - .1 Exposed on wall; Watts BD series
  - .2 Surface mounted (piping in wall); Watts SC-3 series
  - .3 Delta
  - .4 Waltec
  - .5 Wilkins
  - .6 Emco

## **2.3 WATER HAMMER ARRESTORS**

- .1 Copper construction, bellows type: to PDI-WH 201.
- .2 Acceptable material:
  - .1 Zurn Z-1700
  - .2 Mifab MWH-100
  - .3 Ancon No. 15

## **2.4 BACK FLOW PREVENTORS**

- .1 The backflow preventor shall prevent backflow by either backpressure or backsiphonage from a cross-connection between potable water lines and substances that are objectionable.
- .2 To CAN/CSA-B64.
- .3 Application: as indicated.
- .4 Reduced pressure principle type up to 50 mm (2") (RP):  
Rated to 180°F and supplied with full port ball valves. The main body and access covers shall be bronze (ASTM B584), the seat ring and all internal polymers shall be NSF® Listed Noryl™ and the seat disc elastomers shall be SILICONE. The first and second check shall be orientated at a 45° angle up-wards and accessible for maintenance without removing the relief valve. Supplied with an air gap adapter.
  - .1 Acceptable materials:
    - .1 Watts 009 ½" - 2"
    - .2 Wilkins 975 XL ½" - 2"

- .3 Conbraco 40-200 Series
- .5 Reduced pressure principle type from 65 mm (2½") to 250 mm (10") (RP):

The reduced pressure principle backflow preventer shall be ASSE 1013 approved, and supplied with full port gate valves. The main body and access covers shall be epoxy coated cast iron (ASTM A126 Class B), the seat ring and check valve shall be cast bronze (ASTM B584), the stem shall be stainless steel (ASTM A276) and the seat disc elastomers shall be EPDM. The first and second checks shall be accessible for maintenance without removing the relief valve or the entire device from the line.

If installed indoors, the installation shall be supplied with an air gap adapter, strainer, and integral monitor switch.

  - .1 Acceptable materials:
    - .1 Watts 909 2½" - 10"
    - .2 Wilkins 975 2½"- 10" or 375 4"- 6"
    - .3 Conbraco 40-200 Series
- .6 Double check valve assembly (DCVA):

The double check type backflow preventer shall be ASSE 1015 approved, and supplied with full port ball valves. The main body and access covers shall be bronze (ASTM B584), the seat rings and all internal polymers shall be NSF® Listed Noryl™ and the seat disc elastomers shall be silicone. The first and second checks shall be accessible for maintenance without removing the device from the line.

  - .1 Acceptable materials:
    - .1 Watts 007 ½"- 2"
    - .2 Wilkins 950XL ¾ "- 2"
    - .3 Conbraco 40-100 Series
- .7 Double check valve assembly (DCVA)

The double check backflow preventer shall be ASSE 1015 approved, and supplied with full port gate valves. The main body and access covers shall be epoxy coated cast iron (ASTM A126 Class B), the seat ring and check valve shall be cast bronze (ASTM B584), the stem shall be stainless steel (ASTM A276) and the seat disc elastomers shall be EPDM. The checks shall be accessible for maintenance without removing the device from the line.

  - .1 Acceptable materials:
    - .1 Watts 709 2½" - 10"
    - .2 Wilkins 950 2" - 10", 350 4" - 6"
    - .3 Conbraco 40-100 Series
- .8 Back flow preventor with intermediate atmospheric vent:
  - .1 Acceptable material:
    - .1 Watts Series 9D
    - .2 Wilkins 750
    - .3 Conbraco 40-4A Series



## **2.5 VACUUM BREAKERS**

- .1 To CAN/CSA-B64 Series.
- .2 Atmospheric vacuum breaker (A-VB):
  - .1 Acceptable materials:
    - .1 Watts 288A
    - .2 Conbraco 38-103 Series
    - .3 Wilkins 35
  - .3 Hose connection vacuum breaker (HCVB):
    - .1 Acceptable materials:
      - .1 Watts Series 8
      - .2 Conbraco 38-304-AS
      - .3 Wilkins BFP-8

## **2.6 PRESSURE REGULATORS**

- .1 Capacity: as indicated.
  - .1 Inlet pressure: 1034 kPa (150 psi).
  - .2 Outlet pressure: 41 kPa (5.9 psi).
- .2 Up to NPS 40 mm (1 1/2") bronze bodies, screwed: to ASTM B62.
  - .1 Acceptable material:
    - .1 Watts Series 25AUB (1/2" - 2")
- .3 NPS 50 mm (2") and over, semi-steel bodies, Class 125, flanged: to ASTM A126, Class [B].
  - .1 Acceptable materials:
    - .1 Watts PV-10
    - .2 Conbraco 36 Series
- .4 Semi-steel spring chambers with bronze trim.
  - .1 Acceptable materials:
    - .1 Watts PV-10
    - .2 Conbraco 36 Series

## **2.7 WATER METERS (CHECK METERS)**

- .1 **To latest AWWA Standard C700-77**
- .2 **Direct reading registrar, cast bronze main case, positive displacement.**
- .3 **Acceptable material:**
  - .1 Neptune t-10

## **2.8 STRAINERS**

- .1 860 kPa (125 psi), Y type with 20 mm (3/4") mesh, bronze or stainless steel removable screen.

- .2 NPS 50 mm (2") and under, bronze body, screwed ends, with brass cap.
  - .1 Acceptable materials:
    - .1 Watts Series 777SI
    - .2 Crane/Powers
    - .3 Colton 125 YTB
    - .4 Wilkins S Series
- .3 NPS 65 mm (2½") and over, cast iron body, flanged ends, with bolted cap.
  - .1 Acceptable materials:
    - .1 Watts 77F-D (77F-D-FDA for water service)
    - .2 Crane/Powers
    - .3 Colton 125 YTB
    - .4 Wilkins FS Series

## **2.9 WATER FILTERS**

- .1 Five (5) micron filter assembly for taste/odour and dirt/rust.
- .2 The unit shall be constructed of molded transparent plastic housing and a bottom pressure relief for cartridge change.
- .3 Install as per manufacturer's recommendations
- .4 Supply a spare set of cartridges.
- .5 Acceptable material:
  - .1 Aqua Puro AP11B

## **2.10 SOLENOID VALVES**

- .1 Two (2) way normally closed all bronze construction.
- .2 Voltage shall be suitable for controlling function.
- .3 Acceptable material:
  - .1 Asco

## **2.11 OWNER SUPPLIED EQUIPMENT**

- .1 The mechanical contractor shall supply and install all water, gas, condensate and sanitary piping to the owner supplied equipment. Connection to equipment shall be by this contractor.
- .2 Provide flexible riser stops to all sinks and ball valves to all other equipment.
- .3 Provide backflow preventors on equipment required by the local plumbing inspector.
- .4 Provide flexible gas piping to all gas equipment.
- .5 All equipment in store equipment schedule will be supplied and set in place by Mechanical Contractor unless otherwise noted.
- .6 Coordinate all rough-ins and connection with the supplier on site.

- .7 Owner supplied equipment includes existing relocated equipment.

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 Install in accordance with provincial codes, and local authority having jurisdiction.
- .2 Install in accordance with manufacturer's instructions and as specified.

#### **3.2 NON FREEZE WALL HYDRANTS**

- .1 Install 600 mm (24") above finished grade unless otherwise indicated.

#### **3.3 WATER HAMMER ARRESTORS**

- .1 Install on branch supplies to each fixture or group of fixtures and where indicated.

#### **3.4 BACK FLOW PREVENTORS**

- .1 Install in accordance with CAN/CSA-B64 Series, where indicated and elsewhere as required by code.
- .2 Pipe discharge to terminate over nearest drain and or service sink.
- .3 Provide test results in manual and leave tag with test results on device.

#### **3.5 STRAINERS**

- .1 Install with sufficient room to remove basket.
- .2 Strainer size to match pipe size.

#### **3.6 WATER METERS**

- .1 Install water meter provided by local water authority **and/or this contractor**.
- .2 Install water meter as indicated.
- .3 Install remote readout to acceptance of local water authority and as indicated.
- .4 **Install check meter(s) as indicated.**

#### **3.7 COMMISSIONING**

- .1 In context of this paragraph, "verify" to include "demonstrate" to Consultant.
- .2 Timing: commission only after start-up deficiencies rectified.
- .3 Access doors: verify size and location relative to items to be services.
- .4 Adjust to suit site conditions, including, but not necessarily limited to, following:
  - .1 Non-freeze wall, ground hydrants:
    - .1 Verify complete drainage.
    - .2 Verify operation of vacuum breaker.

- .2 Water hammer arrestors:
  - .1 Verify accessibility.
- .3 Backflow preventors, vacuum breakers:
  - .1 Verify installation of correct type to suit application.
  - .2 Adjust as necessary to ensure proper operation.
  - .3 Verify visibility of discharge.
- .4 Pressure regulators:
  - .1 Adjust settings to suit installed locations, required flow rates.
- .5 Hose bibbs, sediment faucets:
  - .1 Verify operation.
- .6 Water make-up assembly:
  - .1 Verify operation.
- .7 Water meters:
  - .1 Verify operation.
- .8 Pipeline strainers:
  - .1 Verify accessibility of basket.
  - .2 Clean out during commissioning until system clean.
- .5 Commissioning reports:
  - .1 Record all results on approved report forms.
  - .2 Include signature of tester and supervisor.
  - .3 To be countersigned by Consultant.
- .6 Verification:
  - .1 Notify Consultant 48 h before commencing tests.
  - .2 All tests and procedures to be witnessed by Consultant.
  - .3 All reported results subject to verification by consultant.
- .7 Training:
  - .1 Train O&M personnel in start-up, operation, monitoring, servicing, maintenance and shut-down procedures.
- .8 Demonstrations:
  - .1 Demonstrate full compliance with Design Criteria.
  - .2 Demonstrations also to show completeness of O&M personnel training.

### **3.8 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.

- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ASTM C117, Test Method for Material Finer Than 0.075 mm (3 mil) Sieve in Mineral Aggregates by Washing.
- .3 ASTM C136, Method for Sieve Analysis of Fine and Coarse Aggregates.
- .4 ASTM D698, Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (600 kN-m/m<sup>3</sup>).
- .5 ASTM D2680, Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
- .6 ASTM D3034, Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- .7 CAN/CSA-B182.1, Plastic Drain and Sewer Pipe and Pipe Fittings.
- .8 CAN/CSA-B182.2, PVC Sewer Pipe and Fittings (PSM Type).
- .9 CSA B182.11, Standard Practice for the Installation of Thermoplastic Drain and Sewer, Storm Pipe and Pipe Fittings.

**1.2                SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Submittals Section.

**1.3                MATERIAL CERTIFICATION**

- .1 Submit manufacturers test data and certification at least 2 weeks prior to commencing work.

**1.4                SCHEDULING OF WORK**

- .1 Schedule work to minimize interruptions to existing services and to maintain existing sewage flows during construction.
- .2 Submit schedule of expected interruptions for approval and adhere to approved schedule.
- .3 Notify the building manager a minimum of 24 hrs in advance of any interruption in service.

**Part 2 Products**

**2.1 PLASTIC PIPE**

- .1 Type PSM Polyvinyl Chloride (PVC): to ASTM D3034 or CAN/CSA-B182.2.
  - .1 Standard Dimensional Ratio SDR 28 35 41.
  - .2 Locked in gasket and integral bell system.
  - .3 Nominal lengths: 6 m (20').

**2.2 CEMENT MORTAR**

- .1 Portland cement: to CAN/CSA-A300 Series, normal type 10.
- .2 Mix mortar one part by volume of cement to two parts of clean, sharp sand mixed dry. Add only sufficient water after mixing to give optimum consistency for placement. Do not use additives.

**2.3 PIPE BEDDING AND SURROUND MATERIALS**

- .1 Granular material to Excavating, Trenching, and Backfilling Section: and following requirements:
  - .1 Crushed or screened stone, gravel or sand.
  - .2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117]. Sieve sizes to CAN/CGSB-8.1.

	<u>Stone/Gravel</u>	<u>Gravel/Sand</u>
200 mm (8")	-	-
75 mm (3")	-	-
50 mm (2")	-	-
40 mm (1 1/2")	-	-
25 mm (1")	100	-
20 mm (3/4")	-	-
15 mm (1/2")	65-90	100
10 mm (3/8")	-	-
5 mm (3/16")	35-55	50-100
2.00 mm (80 mil)	-	30-90
0.425 mm (16 mil)	10-25	10-50
0.180 mm (7 mil)	-	-
<u>0.075 mm (3 mil)</u>	<u>0-8</u>	<u>0-10</u>

- .2 Concrete mixes and materials for cradles, encasement, and supports: to Cast-in-Place Concrete Section.

**2.4 BACKFILL MATERIAL**

- .1 As indicated.
- .2 Type 3, in accordance with Excavating, Trenching and Backfilling Section.
- .3 Unshrinkable fill: to Excavating, Trenching and Backfilling Section.

**Part 3                    Execution**

**3.1                      PREPARATION**

- .1                    Clean and dry pipes and fittings before installation.

**3.2                      TRENCHING**

- .1                    Do trenching work in accordance with Excavating, Trenching and Backfilling Section.
- .2                    Do not allow contents of any sewer or sewer connection to flow into trench.
- .3                    Trench alignment and depth require approval of Consultant prior to placing bedding material and pipe.

**3.3                      GRANULAR BEDDING**

- .1                    Place bedding in unfrozen condition.
- .2                    Place granular bedding materials in uniform layer(s) not exceeding 150 mm (6") compacted thickness to depth of 300 mm (12").
- .3                    Shape bed true to grade and to provide continuous, uniform bearing surface for pipe. Do not use blocks when bedding pipe.
- .4                    Shape transverse depressions as required to suit joints.
- .5                    Compact each layer full width of bed to at least 95% maximum density to ASTM D698.
- .6                    Fill excavation below bottom of specified bedding adjacent to manholes or structures with compacted bedding material.

**3.4                      INSTALLATION**

- .1                    Lay and join pipes in accordance with manufacturer's recommendations.
- .2                    Handle pipe using methods approved. Do not use chains or cables passed through rigid pipe bore so that weight of pipe bears upon pipe ends.
- .3                    Lay pipes on prepared bed, true to line and grade, with pipe invert smooth and free of sags or high points. Ensure barrel of each pipe is in contact with shaped bed throughout its full length.
- .4                    Commence laying at outlet and proceed in upstream direction with socket ends of pipe facing upgrade.
- .5                    Do not exceed maximum joint deflection recommended by pipe manufacturer.
- .6                    Do not allow water to flow through pipe during construction.
- .7                    Whenever work is suspended, install removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
- .8                    Install plastic pipe and fittings in accordance with CSA B182.11.



- .9 Pipe jointing:
  - .1 Install gaskets in accordance with manufacturer's recommendations.
  - .2 Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.
  - .3 Align pipes before joining.
  - .4 Maintain pipe joints free from mud, silt, gravel and other foreign material.
  - .5 Avoid displacing gasket or contaminating with dirt or other foreign material. Gaskets so disturbed shall be removed, cleaned and lubricated and replaced before joining is attempted.
  - .6 Complete each joint before laying next length of pipe.
  - .7 Minimize joint deflection after joint has been made to avoid joint damage.
  - .8 At rigid structures, install pipe joints not more than 1.5 m (5') from side of structure.
  - .9 Apply sufficient pressure in making joints to ensure that joint is complete as outlined in manufacturer's recommendations.
- .10 Cut pipes as required for special inserts, fittings or closure pieces as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.
- .11 Make watertight connections to manholes. Use shrinkage compensating grout when suitable gaskets are not available.
- .12 Use prefabricated saddles or field connections approved by Consultant, for connecting pipes to existing sewer pipes. Joints to be structurally sound and watertight.

### **3.5 PIPE SURROUND**

- .1 Place surround material in unfrozen condition.
- .2 Upon completion of pipe laying, and after Consultant has inspected pipe joints, surround and cover pipes as indicated. Leave joints and fittings exposed until field testing is completed.
- .3 Hand place surround material in uniform layers not exceeding 150 mm (6") compacted thickness as indicated. Do not dump material within 1.0 m (40") of pipe.
- .4 Place layers uniformly and simultaneously on each side of pipe.
- .5 Compact each layer from pipe invert to mid height of pipe to at least 95% maximum density to ASTM D698.
- .6 Compact each layer from mid height of pipe to underside of backfill to at least 90% corrected maximum dry density and maximum density to ASTM D698.
- .7 When field test results are acceptable to Consultant, place surround material at pipe joints.

### **3.6 BACKFILL**

- .1 Place backfill material in unfrozen condition.
- .2 Place backfill material, above pipe surround in uniform layers not exceeding 150 mm (6") compacted thickness up to grades as indicated.
- .3 Under paving and walks, compact backfill to at least 95% maximum density to ASTM D698. In other areas, compact to at least 90% maximum density to ASTM D698.

### **3.7 FIELD TESTING GRAVITY DRAINS**

- .1 Repair or replace pipe, pipe joint or bedding found defective.
- .2 When directed by Consultant, draw tapered wooden plug with diameter of 50 mm (2") less than nominal pipe diameter through sewer to ensure that pipe is free of obstruction.
- .3 Remove foreign material from sewers and related appurtenances by flushing with water.
- .4 Perform infiltration and exfiltration testing as soon as practicable after jointing and bedding are complete, and service connections have been installed.
- .5 Carry out tests on each section of sewer between successive manholes including service connections.
- .6 Install watertight bulkheads in suitable manner to isolate test section from rest of pipeline.
- .7 Exfiltration test:
  - .1 Fill test section with water in such a manner as to allow displacement of air in line. Maintain under nominal head for 24 h to ensure absorption in pipe wall is complete before test measurements are commenced.
  - .2 Immediately prior to test period add water to pipeline until there is a head of 1.0 m (40") over interior crown of pipe measured at highest point of test section or water in manhole is 1.0 m (40") above static ground water level, whichever is greater.
  - .3 Duration of exfiltration test: 2 h.
  - .4 Water loss at end of test period: not to exceed maximum allowable exfiltration over any section of pipe between manholes.
- .8 Repair and retest sewer line as required, until test results are within limits specified.
- .9 Repair visible leaks regardless of test results.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ASTM A126, Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
- .3 ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
- .4 CAN/CSA-B79, Commercial and Residential Drains and Cleanouts.

**1.2 SUBMITTALS**

- .1 Submit shop drawings and product data in accordance with general requirements.
- .2 For shop drawings, indicate dimensions, construction details and materials.
- .3 For product data, indicate dimensions, construction details and materials for all items specified herein.

**1.3 MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.
- .2 Data to include:
  - .1 Description of plumbing specialties and accessories, giving manufacturers name, type, model, year, and capacity.
  - .2 Details of operation, servicing, and maintenance.
  - .3 Recommended spare parts list.

**Part 2 Products**

**2.1 FLOOR DRAINS**

- .1 Floor drains and trench drains: to CAN/CSA-B79.
- .2 **Refer to schedule for types and acceptable manufacturer.**
- .3 Type FD-1: general duty; cast iron body, adjustable head, nickel bronze strainer, integral seepage pan, and clamping collar. Use square strainer in tiled areas and round strainer elsewhere.
  - .1 Acceptable materials:
    - .1 Zurn ZN-415-B
    - .2 Mifab F1100C
    - .3 Watts Drainage FD-100-C-AS-1 or FD-100-C-LS-1
    - .4 Jay R. Smith 2005-AO5NB

- .4 Type HD-1: combination funnel floor drain; cast iron body with integral seepage pan, clamping collar, nickel-bronze adjustable head strainer with integral funnel.

- .1 Acceptable materials:

- .1 Zurn ZN-415-F, ZN-415-BE, ZN-415-BF
    - .2 Mifab F1100C-EG
    - .3 Watts Drainage FD-100-C-EG-1
    - .4 Jay R. Smith 2005-AO5NB-358ONE (3591NB)

## 2.2 CLEANOUTS

- .1 Cleanout plugs: heavy cast iron male ferrule with brass screws and threaded brass or bronze plug. Sealing-caulked lead seat or neoprene gasket.

- .2 Wall access: face or wall type, stainless steel round cover with flush head securing screws, bevelled edge frame complete with anchoring lugs.

- .1 Acceptable material:

- .1 Zurn ZSS-1469
    - .2 Mifab C1400-RD
    - .3 Watts CO-480-RD-3
    - .4 Jay R. Smith 4710

- .3 Floor access: rectangular, round, as indicated, cast iron body and frame with adjustable secured 15 mm ( $\frac{1}{2}$ ") thick flush mounted heavy duty nickel bronze top and:  
Plugs: bolted bronze with neoprene gasket.

- .1 Cover for unfinished concrete floors: nickel bronze round, gasket, vandal-proof screws.

- .1 Acceptable material:

- .1 Zurn ZN-1400 – HD or Zurn ZNX-1612
      - .2 Mifab C1100-XR-6
      - .3 Watts CO-200-RX-1-6
      - .4 Jay R. Smith SQ-4-1753-XNBCO-SP-U

- .2 Cover for terrazzo finish: round polished nickel bronze with recessed cover for filling with terrazzo, vandal-proof locking screws.

- .1 Acceptable materials:

- .1 Zurn ZN-1400-Z
      - .2 Mifab C1100-UR-6
      - .3 Watts CO-200-U-1-6
      - .4 Jay R. Smith SQ-4-1753-NBRT-SP-U

- .3 Cover for VCT tile and linoleum floors: square polished nickel bronze with 15 mm (1/2") thick flush mounted heavy duty nickel bronze cover, complete with vandal-proof locking screws.
  - .1 Acceptable materials:
    - .1 Zurn ZN-1400-T – HD
    - .2 Mifab C1100-TS-6
    - .3 Watts CO-200-TS-1-6
    - .4 Jay R. Smith 4200-U
- .4 Cover for ceramic tile floors: 15 mm (½") thick heavy duty nickel bronze square, cover complete with gasket, vandal-proof screws, for flush finish.
  - .1 Acceptable material:
    - .1 Zurn ZN-1400 – T-HD or Zurn ZNX-1612
    - .2 Mifab C1100-S-6
    - .3 Watts CO-200-S-1-6
    - .4 Jay R. Smith SQ-4-1753-NBCO-SP-U-Y
- .5 Cover for carpeted floors: round polished nickel bronze with flush cover, complete with stainless steel carpet marker, vandal-proof locking screws.
  - .1 Acceptable materials:
    - .1 Zurn ZN-1400-HD-CM or ZN-1612-CM
    - .2 Mifab C1100C-S-1-6
    - .3 Ancon CO-200-RC-1-6
    - .4 Smith
    - .5 Contour C3000RMNB

## **2.3 PRESSURE DROP ACTIVATED TRAP SEAL PRIMER STATION**

- .1 Pressure drop activated, brass construction trap seal primer.
- .2 Provide complete with integral air gap, distribution head suitable to serve up to four (4) drains and low lead isolation ball valve.
- .3 Provide complete with powder coat steel wall mounting box and cover for easy inspection.
- .4 NPS 15 mm (1/2") solder end and NPS 15 mm (1/2") drip line connection.
- .5 All penetrations into enclosure to be sealed with water tight grommets.
- .6 Acceptable manufacturers:
  - .1 Mifab MR-ENC-AG
  - .2 Watts
  - .3 Zurn

## **2.4 TRAP SEAL PRIMER STATIONS**

- .1 Provide trap primer stations where indicated complete with solenoid valve, backflow preventor, vacuum breaker, NPS 15 mm (1/2") solder ends, NPS 15 mm (1/2") drip line connections.
- .2 Solenoid valve electric characteristics shall be suitable for controlling function.
- .3 Coordinate location and number of trap primer stations with Building Automation System (BAS) contractor.
- .4 Acceptable manufacturers:
  - .1 Mifab
  - .2 Watts
  - .3 Zurn

## **2.5 SOLENOID VALVES (HEADER TRAP SEAL PRIMER)**

- .1 Two (2) way normal closed all bronze construction.
- .2 With integral adjustable cycle time clock control. Timer control to have two dial functions, time between cycles and time held in "open position".
- .3 Suitable for 120V.
- .4 Acceptable material:
  - .1 Asco

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install in accordance with provincial codes, and local authority having jurisdiction.
- .2 Install in accordance with manufacturer's instructions and as specified.

### **3.2 CLEANOUTS**

- .1 In addition to those required by code, and as indicated, install at base of all soil and waste stacks.
- .2 Bring cleanouts to wall or finished floor unless serviceable from below floor.
- .3 Building drain cleanout and stack base cleanouts: line size to maximum NPS 100 mm (4").

### **3.3 TRAP SEAL PRIMERS**

- .1 Install for all floor, hub and trench drains and elsewhere, as indicated.
- .2 Install on cold water supply to nearest frequently used plumbing fixture, in concealed space, to approval of Consultant.
- .3 Install soft copper tubing to floor drains above grade and polyethylene piping to floor drains below grade.

### **3.4 TRAP SEAL PRIMER STATIONS**

- .1 Provide primer stations where indicated.
- .2 Install for all floor drains and elsewhere, as indicated.
- .3 Install copper piping to floor drains above grade. Install polypropylene piping to floor drains on grade.

### **3.5 COMMISSIONING**

- .1 In context of this paragraph, "verify" to include "demonstrate" to Consultant.
- .2 Timing: commission only after start-up deficiencies rectified.
- .3 Access doors: verify size and location relative to items to be services.
- .4 Adjust to suit site conditions, including, but not necessarily limited to, following:
  - .1 Floor, hub and trench drains:
    - .1 Verify proper operation of trap primer, flushing features.
    - .2 Verify security and removability of strainers.
  - .2 Cleanouts:
    - .1 Verify covers are gastight, secure and easily removable.
    - .2 Verify that cleanout rods can probe as far as next cleanout.
  - .3 Trap seal primers:
    - .1 Verify operation.
    - .2 Adjust flow rate to suit site conditions.
  - .4 Acid dilution devices:
    - .1 Verify operation.
- .5 Commissioning reports:
  - .1 Record all results on approved report forms.
  - .2 Include signature of tester and supervisor.
  - .3 To be countersigned by Consultant.
- .6 Verification:
  - .1 Notify Consultant 48 h before commencing tests.
  - .2 All tests and procedures to be witnessed by Consultant.
  - .3 All reported results subject to verification by consultant.
- .7 Training:
  - .1 Train O&M personnel in start-up, operation, monitoring, servicing, maintenance and shut-down procedures.
- .8 Demonstrations:
  - .1 Demonstrate full compliance with Design Criteria.
  - .2 Demonstrations also to show completeness of O&M personnel training.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ASTM B32, Specification for Solder Metal.
- .3 ASTM B306, Specification for Copper Drainage Tube (DWV).
- .4 ASTM C564, Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- .5 CAN/CSA-B70, Cast Iron Soil Pipe, Fittings and Means of Joining.
- .6 CAN/CSA-B125.3, Plumbing Fittings.

**Part 2            Products**

**2.1            COPPER TUBE AND FITTINGS**

- .1 Above ground sanitary, and vent, maximum 65 mm (2½") Type DWV copper to: ASTM B306.
  - .1 Fittings.
    - .1 Cast brass: to CAN/CSA B125.3.
    - .2 Wrought copper: to CAN/CSA B125.3.
  - .2 Solder: tin-lead, 50:50, to ASTM B32, type 50A.

**2.2            CAST IRON PIPING AND FITTINGS**

- .1 Above ground sanitary, and vent, minimum NPS 80 mm (3"), cast iron to: CAN/CSA-B70.
  - .1 Mechanical joints (vents)
    - .1 Neoprene or butyl rubber compression gaskets: to ASTM C564 or CAN/CSA-B70.
    - .2 Stainless steel clamps (2 band).
  - .2 Mechanical joints (sanitary)
    - .1 Heavy duty neoprene or butyl rubber compression gaskets to: ASTM C1540.
    - .2 Stainless steel clamps (4 band min).

**2.3            VENT FLASHINGS**

- .1 Thaler or equal spun aluminum complete with insulation, cap, and rubber gasket.



**Part 3            Execution**

**3.1                INSTALLATION**

- .1      Install in accordance with Provincial Plumbing Code and local authority having jurisdiction.
- .2      Install above ground piping parallel and close to walls and ceilings to conserve headroom and space, and to grade as indicated.
- .3      Place Cleanouts
  - .1          Where shown on Drawings and near bottom of each stack and riser.
  - .2          At every 90 degree change of direction for horizontal lines.
  - .3          Every 15 m (50') of horizontal run.
  - .4          Extend clean out to accessible surface. Do not place cleanouts in carpeted floors. In such locations, use wall type cleanouts.
- .4      Each fixture and appliance discharging water into sanitary sewer or building sewer lines shall have a seal trap in connection with a complete venting system so gases pass freely to atmosphere with no pressure or syphon condition on water seal.
- .5      Vent entire waste system to atmosphere.
  - .1          Discharge 500 mm (20") above roof. Join lines together in fewest practicable number before projecting above roof.
  - .2          Set back vent lines so they will not pierce roof near an edge or valley.
  - .3          Venting shall be 7.5 m (25'-0") from any outdoor air intakes.
  - .4          Provide copper vent piping through roof as per detail.
- .6      Use torque wrench to obtain proper tension in cinch bands when using hubless cast iron pipe. Butt ends of pipe against centering flange of coupling.
- .7      Flash pipes passing through roof with 453 g (16 oz) sheet copper flashing fitted snugly around pipes and caulk between flashing and pipe with flexible waterproof compound.
  - .1          Flashing base shall be at least 600 mm (24") square.
  - .2          Flashing may be a 24 kg/m<sup>2</sup> (5 lb/ft<sup>2</sup>) lead flashing fitted around pipes and turned down into pipe 15 mm (½") with turned edge hammered against pipe wall.
- .8      Before piping is covered, conduct tests in presence of Consultant and correct leaks or defective work. Conduct test prior to placing floor slab but after backfill is placed.
  - .1          Do not caulk threaded work.
  - .2          Fill waste and vent system to roof level [a minimum of 3,100 mm - (10')] with water and show no leaks for 2 hours.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ASTM D2235, Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
- .3 ASTM D2564, Specification for Solvent Cements for Poly(Vinyl-Chloride) (PVC) Plastic Piping Systems.
- .4 CAN/CSA-B181.1, ABS Drain, Waste and Vent Pipe and Pipe Fittings.
- .5 CAN/CSA-B181.2, PVC and CPVC Drain, Waste and Vent Pipe and Pipe Fittings.
- .6 CAN/CSA-B182.1, Plastic Drain and Sewer Pipe and Pipe Fittings.

**Part 2            Products**

**2.1                PIPING AND FITTINGS**

- .1 Buried sanitary, and vent piping to:
  - .1 80 mm (3") and smaller: ABS drain waste and vent pipe to CAN/CSA-B181.1.
  - .2 100 mm (4") and larger: SDR-35 PVC drain waste and vent pipe to CAN/CSA-B181.2.
  - .3 Vent piping: any size, PVC-DWV plastic drain and sewer pipe and fittings CAN/CSA-B181.2.
- .2 Above grade sanitary and vent piping:
  - .1 80 mm (3") and smaller: IPEX: PVC-XFR drain waste and vent pipe to CAN/CSA-B181.2.
  - .2 100 mm (4") and larger: IPEX: PVC-XFR drain waste and vent pipe to CAN/CSA-B181.2.
  - .3 Vent piping: any size, IPEX: PVC-XFR plastic drain and sewer pipe and fittings CAN/CSA-B181.2.
- .3 Where piping pierces a fire separation an approved fire stop system to the approval of authority having jurisdiction shall be used.

**2.2                JOINTS**

- .1 Solvent weld for PVC: to ASTM D2564.
- .2 Solvent weld for ABS: to ASTM D2235.

**2.3                EXPANSION**

- .1 Provide solvent welded expansion joints as required by manufacturer's recommendations.

## **2.4 VENT FLASHINGS**

- .1 Thaler Stack Jack spun aluminum complete with insulation, cap, and rubber gasket.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install in accordance with Provincial Plumbing Code and local authority having jurisdiction. Install in accordance with manufacturer's instructions.
- .2 Installation of underground pipe
  - .1 Provide all excavation, bedding, backfill, and compaction.
  - .2 Install materials in accordance with Manufacturer's instructions.
  - .3 Use jacks to make-up gasketed joints.
  - .4 Stabilize unstable trench bottoms.
  - .5 Bed pipe true to line and grade with continuous support from firm base.
    - .1 Bedding depth - 100 mm to 150 mm (4" to 6").
    - .2 Material and compaction to meet ASTM standard noted above.
  - .6 Excavate bell holes into bedding material so pipe is uniformly supported along its entire length. Blocking to grade pipe is forbidden.
  - .7 Trench width at top of pipe -
    - .1 Minimum 450 mm (18") or diameter of pipe plus 300 mm (12"), whichever is greater.
    - .2 Maximum - Outside diameter of pipe plus 600 mm (24").
  - .8 Piping and joints shall be clean and installed according to manufacturer's recommendations. Break down contaminated joints, clean seats and gaskets and reinstall.
  - .9 Do not use back hoe or power equipment to assemble pipe.
  - .10 Initial backfill shall be 300 mm (12") above top of pipe with material specified in referenced ASTM standard.
- .3 Place Cleanouts
  - .1 Where shown on Drawings and near bottom of each stack and riser.
  - .2 At every 90 degree change of direction for horizontal lines.
  - .3 Every 15 m (50 ft) of horizontal run.
  - .4 Extend clean out to accessible surface. Do not place cleanouts in carpeted floors. In such locations, use wall type cleanouts
- .4 Each fixture and appliance discharging water into sanitary sewer or building sewer lines shall have a seal trap in connection with a complete venting system so gases pass freely to atmosphere with no pressure or syphon condition on water seal.

- 
- .5 Before piping is covered, conduct tests in presence of Consultant and correct leaks or defective work. Conduct test prior to placing floor slab but after backfill is placed.
    - .1 Fill waste and vent system a minimum of 1.8 m (6 ft) above finished floor with water and show no leaks for 2 hours.
    - .2 Conduct ball test in presence of consultant to ensure proper grade and clear of obstructions.
  - .6 Install solvent welded expansion joints as per manufacturer's recommendation. Care is to taken to accommodate ambient temperatures at time of install.
  - .7 Vent entire waste system to atmosphere.**
    - .1 Discharge 350 mm (14") above roof. Join lines together in fewest practicable number before projecting above roof.**
    - .2 Set back vent lines so they will not pierce roof near an edge or valley.**
    - .3 Venting shall be 7.5 m (25'-0") from any outdoor air intakes.**
  - .8 Flash pipes passing through roof with Thaler insulated Stack Jack flashing.**
    - .1 Flashing base shall be at least 600 mm (24") square.**
  - .9 Install above ground piping parallel and close to walls and ceilings to conserve headroom and space, and to grade as indicated.**

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ASTM A126, Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
- .3 ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
- .4 CAN/CSA-B79, Commercial and Residential Drains and Cleanouts.
- .5 PDI-WH201, Water Hammer Arresters.
- .6 CAN/CSA-B64 Series, Backflow Preventers and Vacuum Breakers.
- .7 PDI-G101, Testing and Rating Procedure for Grease Interceptors.**
- .8 CAN/CSA-B481 Senes12, Grease Interceptors.**

**1.2 SUBMITTALS**

- .1 Submit shop drawings and product data in accordance with general requirements.
- .2 For shop drawings, indicate dimensions, construction details and materials.
- .3 For product data, indicate dimensions, construction details and materials for all items specified herein.

**1.3 MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.
- .2 Data to include:
  - .1 Description of plumbing specialties and accessories, giving manufacturers name, type, model, year and capacity.
  - .2 Details of operation, servicing and maintenance.
  - .3 Recommended spare parts list.

**Part 2 Products**

**2.1 ENZYMATIC GREASE INTERCEPTORS (STEEL)**

- .1 Enzymatic type interceptor, tested and rated in accordance with PDI G101, complete with acid resistant interior enamel finish for mounting flush with floor with non-skid covers on floor complete with flow control fitting suitably vented, and extension.
- .2 Capacity:
  - .1 Refer to Schedules.
- .3 Supply one (1) case of four 1 kg (2.2 lb) cans of enzyme activator with interceptors.
- .4 Provide extensions as required to suit finished floor elevation and installed depth.

- .5 Provide secondary flow control devices for all interceptors that serve fixtures installed more than one storey above unit.
- .6 Acceptable materials:
  - .1 Zurn Z-1170 (Canadian Market)
  - .2 Mifab (with confirmation of CSA compliance)
  - .3 Jay R Smith (with confirmation of CSA compliance)
  - .4 Ancon WD-CSA (-X if extension required / -E 2lbs of Biomix powder)

## **2.2 HYDROMECHANICAL GREASE INTERCEPTORS (PLASTIC)**

- .1 Hydromechanical type interceptor, tested and rated in accordance with the Environmental Protection Act (EPA), complete with fire resistant polypropylene construction for mounting flush with floor with aluminum non-skid covers on floor complete with flow control fitting suitably vented, and extension.
- .2 Capacity:
  - .1 Refer to Schedules.
- .3 The unit shall be able to treat effluent to less than 100 mg/litre of oil and grease.
- .4 Provide extensions as required to suit finished floor elevation and installed depth.
- .5 Provide secondary flow control devices for all interceptors that serve fixtures installed more than one storey above unit.
- .6 Acceptable material:
  - .1 Canplas Endura
  - .2 JRC Plastic Interrupters and Pit Boxes (Tel: 1-416-453-2364) (with confirmation of CSA compliance)
  - .3 Jonespec (with confirmation of CSA compliance)
  - .4 Contour (with confirmation of CSA compliance)GRAVITY GREASE INTERCEPTOR (FIBREGLASS)

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install in accordance with provincial codes, and local authority having jurisdiction.
- .2 Install in accordance with manufacturer's instructions and as specified.

### **3.2 INTERCEPTORS**

- .1 Install with sufficient space, as indicated, for ease of maintenance.

### **3.3 COMMISSIONING**

- .1 In context of this paragraph, "verify" to include "demonstrate" to Consultant.
- .2 Timing: commission only after start-up deficiencies rectified.

- 
- .3 Access doors: verify size and location relative to items to be services.
  - .4 Adjust to suit site conditions, including, but not necessarily limited to, following:
    - .1 Grease interceptors:
      - .1 Activate, using manufacturer's recommended activation procedures and materials.
  - .5 Commissioning reports:
    - .1 Record all results on approved report forms.
    - .2 Include signature of tester and supervisor.
    - .3 To be countersigned by Consultant.
  - .6 Verification:
    - .1 Notify Consultant 48 h before commencing tests.
    - .2 All tests and procedures to be witnessed by Consultant.
    - .3 All reported results subject to verification by consultant.
  - .7 Training:
    - .1 Train O&M personnel in start-up, operation, monitoring, servicing, maintenance and shut-down procedures.
  - .8 Demonstrations:
    - .1 Demonstrate full compliance with Design Criteria.
    - .2 Demonstrations also to show completeness of O&M personnel training.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ASTM C14M, Specification for Non-reinforced Concrete Sewer, Storm Drain and Culvert Pipe.
- .3 ASTM C76M, Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe.
- .4 ASTM C117, Test Method for Material Finer Than 0.075 mm (3 mil) Sieve in Mineral Aggregates by Washing.
- .5 ASTM C136, Method for Sieve Analysis of fine and Coarse Aggregates.
- .6 ASTM C443M, Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
- .7 ASTM D2680, Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
- .8 ASTM D3034, Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- .9 CAN/CSA-A3001, Cementitious Materials for Use in Concrete.
- .10 ASTM C700, Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
- .11 CAN/CSA-A257, Standards for Concrete Pipe and Manhole Sections.
- .12 CAN/CSA-B182.1, Plastic Drain and Sewer Pipe and Pipe Fittings.
- .13 CAN/CSA-B182.2, PVC Sewer Pipe and Fittings (PSM Type).
- .14 CSA B182.11, Standard Practice for the Installation of Thermoplastic Drain, Storm, and Sewer Pipe and Pipe Fittings.
- .15 CAN/CGSB-8.1, Sieves Testing, Woven Wire.
- .16 CAN/CGSB-8.2, Sieves Testing, Woven Wire, Metric.

**1.2 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Submittals Section.

**1.3 MATERIAL CERTIFICATION**

- .1 Submit manufacturers test data and certification at least 2 weeks prior to commencing work.

**1.4 SCHEDULING OF WORK**

- .1 Schedule work to minimize interruptions to existing services and to maintain existing flow during construction.



- .2 Submit schedule of expected interruptions for approval and adhere to approved schedule.

## 1.5 STANDARDS

- .1 To local Municipal Standards.
- .2 To Ontario Provincial Standards (OPS) for Roads and Municipal Services.

## Part 2 Products

### 2.1 CONCRETE PIPE

- .1 Non-reinforced circular concrete pipe and fittings: to CAN/CSA-A257, ASTM C14M 300 mm (12") and smaller diameter, Class 100D, designed for flexible rubber gasket joints to ASTM C443M CSA A257.
- .2 Reinforced circular concrete pipe and fittings: to CAN/CSA-A257, ASTM C76M 450 mm (18") and larger diameter, strength classification 100 D, designed for flexible rubber gasket joints to ASTM C443M CAN/CSA A257.

### 2.2 PLASTIC PIPE

- .1 Large diameter, ribbed PVC sewer pipe and fittings: to CAN/CSA B182.4 ASTM F794.
  - .1 Standard dimension ratio SDR 35
  - .2 Gasket and integral bell system
  - .3 Nominal length 6 m (20').

### 2.3 PIPE BEDDING AND SURROUND MATERIAL

- .1 Granular material to Excavating, Trenching, and Backfilling Section and following requirements:
  - .1 Crushed or screened stone, gravel or sand.
  - .2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.1.

	<u>Stone/Gravel</u>	<u>Gravel/Sand</u>
200 mm (8")	-	-
75 mm (3")	-	-
50 mm (2")	-	-
40 mm (1 1/2")	-	-
25 mm (1")	100	-
20 mm (3/4")	-	-
15 mm (1/2")	65-90	100
10 mm (3/8")	-	-
5 mm (3/16")	35-55	50-100
2.00 mm (80 mil)	-	30-90
0.425 mm (16 mil)	10-25	10-50
0.180 mm (7 mil)	-	-
0.075 mm (3 mil)	0-8	0-10

- .2 Concrete mixes and materials for bedding, cradles, encasement, and supports: to Cast-in-Place Concrete Section.

## **2.4 BACKFILL MATERIAL**

- .1 As indicated.
- .2 Type 3 to Excavating Trenching and Backfilling Section.

## **Part 3 Execution**

### **3.1 PREPARATION**

- .1 Clean pipes and fittings of debris and water before installation, and remove defective materials from site to approval of Consultant.

### **3.2 TRENCHING**

- .1 Do trenching work in accordance with Excavating, Trenching and Backfilling Section.
- .2 Do not allow contents of any sewer or sewer connection to flow into trench.
- .3 Trench alignment and depth to approval of Consultant prior to placing bedding material and pipe.

### **3.3 GRANULAR BEDDING AND PIPE SURROUND**

- .1 Place bedding in unfrozen condition.
- .2 Place granular bedding material in uniform layers not exceeding 150 mm (6") compacted thickness to depth of as indicated.
- .3 Shape bed true to grade and to provide continuous, uniform bearing surface for pipe. Do not use blocks when bedding pipes.
- .4 Shape transverse depressions as required to suit joints.
- .5 Compact each layer full width of bed to at least 95% maximum density to ASTM D698.
- .6 Fill excavation below bottom of specified bedding adjacent to manholes or catch basins with compacted bedding material.
- .7 Hand place surround material in uniform layers not exceeding 150 mm compacted thickness as indicated. Do not dump material within 1.0 m of pipe.
- .8 Compact each layer from native material to 300 mm (12") above pipe to at least 95% corrected maximum dry density.

### **3.4 INSTALLATION**

- .1 Lay and join pipe in accordance with manufacturer's recommendations and to approval of Consultant.
- .2 Handle pipe using methods approved by Consultant. Do not use chains or cables passed through rigid pipe bore so that weight of pipe bears upon pipe ends.

- .3 Lay pipes on prepared bed, true to line and grade with pipe inverts smooth and free of sags or high points. Ensure barrel of each pipe is in contact with shaped bed throughout its full length.
- .4 Commence laying at outlet and proceed in upstream direction with socket ends of pipe facing upgrade.
- .5 Do not exceed maximum joint deflection recommended by pipe manufacturer.
- .6 Do not allow water to flow through pipes during construction.
- .7 Install plastic pipe and fittings in accordance with CSA B182.11.
- .8 Cut pipes as required for special inserts, fittings or closure pieces, as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.
- .9 Make watertight connections to manholes and catch basins. Use shrinkage compensating grout when suitable gaskets are not available.
- .10 Use prefabricated saddles or approved field connections for connecting pipes to existing sewer pipes. Joint to be structurally sound and watertight.
- .11 Temporarily plug open upstream ends of pipes with removable watertight concrete, steel or plastic bulkheads.

### **3.5 PIPE SURROUND**

- .1 Place surround material in unfrozen condition.
- .2 Upon completion of pipe laying, and after Consultant has inspected pipe joints, surround and cover pipes as indicated. Leave joints and fittings exposed until field testing is completed.
- .3 Hand place surround material in uniform layers not exceeding 150 mm (6") compacted thickness as indicated. Do not dump material within 1.0 m (40") of pipe.
- .4 Place layers uniformly and simultaneously on each side of pipe.
- .5 Compact each layer from pipe invert to mid height of pipe to at least 95% corrected maximum dry density.
- .6 Compact each layer from mid height of pipe to underside of backfill to at least 90% corrected maximum dry density.
- .7 When field test results are acceptable to Consultant, place surround material at pipe joints.

### **3.6 BACKFILL**

- .1 Place backfill material in unfrozen condition.
- .2 Place backfill material, above pipe surround, in uniform layers not exceeding 150 mm (6") compacted thickness up to grades as indicated.
- .3 Under paving and walks, compact backfill to at least 95% corrected maximum dry density maximum density to ASTM D698. In other areas, compact backfill to at least 90% maximum density to ASTM D698.

**3.7 FIELD TESTING**

- .1 Repair or replace pipe, pipe joint or bedding found defective.
- .2 When directed by Consultant, draw tapered wooden plug with diameter of 50 mm (2") less than nominal pipe diameter through sewer to ensure that pipe is free of obstruction.
- .3 Remove foreign material from sewers and related appurtenances by flushing with water.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ASTM B32, Specification for Solder Metal.
- .3 ASTM B306, Specification for Copper Drainage Tube (DWV).
- .4 ASTM C564, Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- .5 CAN/CSA-B70, Cast Iron Soil Pipe, Fittings and Means of Joining.
- .6 CAN/CSA-B125.3, Plumbing Fittings.

**Part 2            Products**

**2.1            COPPER TUBE AND FITTINGS**

- .1 Above ground storm maximum 65 mm (2½") Type DWV copper to: ASTM B306.
  - .1 Fittings.
    - .1 Cast brass: to CAN/CSA B125.3.
    - .2 Wrought copper: to CAN/CSA B125.3.
  - .2 Solder: tin-lead, 50:50, to ASTM B32, type 50A.

**2.2            CAST IRON PIPING AND FITTINGS**

- .1 Above ground storm minimum NPS 80 mm (3"), cast iron to: CAN/CSA-B70.
  - .1 Mechanical joints (storm)
    - .1 Heavy duty neoprene or butyl rubber compression gaskets to: ASTM C1540.
    - .2 Stainless steel clamps (4 band min).

**Part 3            Execution**

**3.1            INSTALLATION**

- .1 Install in accordance with Provincial Plumbing Code and local authority having jurisdiction.
- .2 Install above ground piping parallel and close to walls and ceilings to conserve headroom and space, and to grade as indicated.
- .3 Place Cleanouts
  - .1 Where shown on Drawings and near bottom of each stack and riser.
  - .2 At every 90 degree change of direction for horizontal lines.
  - .3 Every 15 m (50') of horizontal run.

- .4 Extend clean out to accessible surface. Do not place cleanouts in carpeted floors. In such locations, use wall type cleanouts.
- .4 Use torque wrench to obtain proper tension in cinch bands when using hubless cast iron pipe. Butt ends of pipe against centering flange of coupling.
- .5 Before piping is covered, conduct tests in presence of Consultant and correct leaks or defective work. Conduct test prior to placing floor slab but after backfill is placed.
  - .1 Do not caulk threaded work.
  - .2 Fill waste and vent system to roof level [a minimum of 3,100 mm - (10')] with water and show no leaks for 2 hours.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ASTM D2235, Specification for Solvent Cement for Acrylonitrille-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
- .3 ASTM D2564, Specification for Solvent Cements for Poly(Vinyl-Chloride) (PVC) Plastic Piping Systems.
- .4 CAN/CSA-B181.1, ABS Drain, Waste and Vent Pipe and Pipe Fittings.
- .5 CAN/CSA-B181.2, PVC and CPVC Drain, Waste and Vent Pipe and Pipe Fittings.
- .6 CAN/CSA-B182.1, Plastic Drain and Sewer Pipe and Pipe Fittings.

**Part 2            Products**

**2.1            PIPING AND FITTINGS**

- .1 Buried storm piping to:
  - .1 80 mm (3") and smaller: ABS drain pipe to CAN/CSA-B181.1.
  - .2 100 mm (4") and larger: SDR-35 PVC drain pipe to CAN/CSA-B181.2.
- .2 Above grade storm piping:
  - .1 80 mm (3") and smaller: IPEX: PVC-XFR fire rated drain storm pipe to CAN/CSA-B181.1.
  - .2 100 mm (4") and larger: IPEX: PVC-XFR storm pipe to CAN/CSA-B181.2.
- .3 Where piping pierces a fire separation an approved fire stop system to the approval of authority having jurisdiction shall be used.

**2.2            JOINTS**

- .1 Solvent weld for PVC: to ASTM D2564.
- .2 Solvent weld for ABS: to ASTM D2235.

**Part 3            Execution**

**3.1            INSTALLATION**

- .1 Install in accordance with Provincial Plumbing Code and local authority having jurisdiction.
- .2 Installation of underground pipe
  - .1 Provide all excavation, bedding, backfill, and compaction.
  - .2 Install materials in accordance with Manufacturer's instructions.

- .3 Use jacks to make-up gasketed joints.
- .4 Stabilize unstable trench bottoms.
- .5 Bed pipe true to line and grade with continuous support from firm base.
  - .1 Bedding depth - 100 mm to 150 mm (4" to 6").
  - .2 Material and compaction to meet ASTM standard noted above.
- .6 Excavate bell holes into bedding material so pipe is uniformly supported along its entire length. Blocking to grade pipe is forbidden.
- .7 Trench width at top of pipe -
  - .1 Minimum 450 mm (18") or diameter of pipe plus 300 mm (12"), whichever is greater.
  - .2 Maximum - Outside diameter of pipe plus 600 mm (24").
- .8 Piping and joints shall be clean and installed according to manufacturer's recommendations. Break down contaminated joints, clean seats and gaskets and reinstall.
- .9 Do not use back hoe or power equipment to assemble pipe.
- .10 Initial backfill shall be 300 mm (12") above top of pipe with material specified in referenced ASTM standard.
- .3 Place Cleanouts
  - .1 Where shown on Drawings and near bottom of each stack and riser.
  - .2 At every 90 degree change of direction for horizontal lines.
  - .3 Every 15 m (50 ft) of horizontal run.
  - .4 Extend clean out to accessible surface. Do not place cleanouts in carpeted floors. In such locations, use wall type cleanouts
- .4 Before piping is covered, conduct tests in presence of Consultant and correct leaks or defective work. Conduct test prior to placing floor slab but after backfill is placed.
  - .1 Fill waste and vent system a minimum of 1.8 m (6 ft) above finished floor with water and show no leaks for 2 hours.
  - .2 Conduct ball test in presence of consultant to ensure proper grade and clear of obstructions.

**END OF SECTION**



**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ASTM A126, Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
- .3 ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
- .4 CAN/CSA-B79, Commercial and Residential Drains and Cleanouts.

**1.2            SUBMITTALS**

- .1 Submit shop drawings and product data in accordance with general requirements.
- .2 For shop drawings, indicate dimensions, construction details and materials.
- .3 For product data, indicate dimensions, construction details and materials for all items specified herein.

**1.3            MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.
- .2 Data to include:
  - .1 Description of plumbing specialties and accessories, giving manufacturers name, type, model, year and capacity.
  - .2 Details of operation, servicing and maintenance.
  - .3 Recommended spare parts list.

**Part 2            Products**

**2.1            ROOF DRAINS**

- .1 As indicated on schedules.
- .2 Type RD-1: controlled flow; cast iron body, under deck clamp and sump receiver to suit roof construction, flashing clamp ring with integral gravel stop, bearing pan, flow control weir assembly, aluminum dome.
  - .1 Acceptable material:
    - .1 Zurn ZACF121RC
    - .2 Mifab R1200-F
    - .3 WATTS RD-100-ABDK (80)
    - .4 Jay R. Smith 1083-R-C-AD

- .3 Type RD-2: standard roof drain with cast iron body with aluminum dome, under-deck clamp to suit roof construction, roof sump receiver, flashing clamp ring with integral gravel stop.

- .1 Acceptable materials:

- .1 Zurn ZA-121-ERC
- .2 Mifab R1200-BW
- .3 Ancon RD-100-BEDK (80)
- .4 Smith
- .5 Contour C1000DMP

## 2.2 CLEANOUTS

- .1 Cleanout plugs: heavy cast iron male ferrule with brass screws and threaded brass or bronze plug. Sealing-caulked lead seat or neoprene gasket.
- .2 Wall access: face or wall type, stainless steel round cover with flush head securing screws, bevelled edge frame complete with anchoring lugs.

- .1 Acceptable material:

- .1 Zurn ZSS-1469
- .2 Mifab C1400-RD
- .3 WATTS CO-480-RD-3
- .4 Jay R. Smith SQ-A-1753-XNBCO-SP-U

- .3 Floor access: rectangular, round, as indicated, cast iron body and frame with adjustable secured 15 mm (½") thick flush mounted heavy duty nickel bronze top and: Plugs: bolted bronze with neoprene gasket.

- .1 Cover for unfinished concrete floors: nickel bronze round, gasket, vandal-proof screws.

- .1 Acceptable material:

- .1 Zurn ZN-1400 – HD or Zurn ZZN-1612
- .2 Mifab C1100-XR-6
- .3 WATTS CO-200-RX-1-6
- .4 Jay R. Smith SQ-4-1753-XNBCO-SP-U

- .2 Cover for terrazzo finish: round polished nickel bronze with recessed cover for filling with terrazzo, vandal-proof locking screws.

- .1 Acceptable materials:

- .1 Zurn ZN-1400-Z
- .2 Mifab C1100-UR-6
- .3 WATTS CO-200-TS-1-6
- .4 Jay R. Smith SQ-4-1753-NBRT-SP-U

- .3 Cover for VCT tile and linoleum floors: square polished nickel bronze with 15 mm (1/2") thick flush mounted heavy duty nickel bronze cover, complete with vandal-proof locking screws.
  - .1 Acceptable materials:
    - .1 Zurn ZN-1400-T – HD
    - .2 Mifab C1100-TS-6
    - .3 WATTS CO-200-S-1-6
    - .4 Jay R. Smith 4200-U
- .4 Cover for ceramic tile floors: 15 (½") thick heavy duty nickel bronze square, cover complete with gasket, vandal-proof screws, for flush finish.
  - .1 Acceptable material:
    - .1 Zurn ZN-1400 – T-HD or Zurn ZNX-1612
    - .2 Mifab C1100-S-6
    - .3 WATTS CO-200-RC-1-6
    - .4 Jay R. Smith SQ-4-1753-NBCO-SP-U-Y
- .5 Cover for carpeted floors: round polished nickel bronze with flush cover, complete with stainless steel carpet marker, vandal-proof locking screws.
  - .1 Acceptable materials:
    - .1 Zurn ZN-1400-HD-CM or ZN-1612-CM
    - .2 Mifab C1100C-S-1-6
    - .3 Ancon CO-200-RC-1-6
    - .4 Smith
    - .5 Contour C3000RMNB

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 Install in accordance with provincial codes, and local authority having jurisdiction.
- .2 Install in accordance with manufacturer's instructions and as specified.
- .3 Install roof drains in lowest point of roof. Co-ordinate location with architectural, structural, and mechanical drawings.

#### **3.2 CLEANOUTS**

- .1 In addition to those required by code, and as indicated, install at base of all soil and waste stacks, and rainwater leaders.
- .2 Bring cleanouts to wall or finished floor unless serviceable from below floor.
- .3 Building drain cleanout and stack base cleanouts: line size to maximum NPS 100 mm (4").

### **3.3 COMMISSIONING**

- .1 In context of this paragraph, "verify" to include "demonstrate" to Consultant.
- .2 Timing: commission only after start-up deficiencies rectified.
- .3 Access doors: verify size and location relative to items to be services.
- .4 Adjust to suit site conditions, including, but not necessarily limited to, following:
  - .1 Roof drains:
    - .1 Verify installation at low points in roof.
    - .2 Verify security and removability of dome.
    - .3 Adjust weirs to suit actual roof slope and meet requirements of design.
    - .4 Verify provision for movement of roof and integrity of roof drain piping system.
  - .2 Cleanouts:
    - .1 Verify covers are gastight, secure and easily removable.
    - .2 Verify that cleanout rods can probe as far as next cleanout.
  - .3 Backwater valves:
    - .1 Verify accessibility of cover, valve.
- .5 Commissioning reports:
  - .1 Record all results on approved report forms.
  - .2 Include signature of tester and supervisor.
  - .3 To be countersigned by Consultant.
- .6 Verification:
  - .1 Notify Consultant 48 h before commencing tests.
  - .2 All tests and procedures to be witnessed by Consultant.
  - .3 All reported results subject to verification by consultant.
- .7 Training:
  - .1 Train O&M personnel in start-up, operation, monitoring, servicing, maintenance and shut-down procedures.
- .8 Demonstrations:
  - .1 Demonstrate full compliance with Design Criteria.
  - .2 Demonstrations also to show completeness of O&M personnel training.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ANSI Z21.10.1/CSA 4.1, Gas Water Heaters Volume I, Storage Water Heaters with Inputs Ratings of 75,000 Btuh, or less.
- .3 ANSI Z21.10.3/CSA 4.3, Gas Water Heaters Volume III; Storage Water Heaters with Input Ratings above 75,000 Btuh, circulating and Instantaneous.
- .4 CSA-B149.1, Natural Gas and Propane Installation Code.
- .5 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.
- .6 CAN/CSA-B139, Installation Code for Oil Burning Equipment.
- .7 CAN/CSA-B140.0, Oil Burning Equipment: General Requirements.
- .8 CSA B140.12, Oil Burning Equipment: Service Water Heaters for Domestic Hot Water, Space Heating, and Swimming Pools.
- .9 CAN/CSA-C309, Performance Requirements for Glass-Lined Storage Tanks for Household Hot Water Service.

**1.2            SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with general requirements.
- .2 Indicate:
  - .1 Equipment, including connections, fittings, control assemblies and ancillaries, identifying factory and field assembled.
  - .2 Wiring and schematic diagrams.
  - .3 Dimensions and recommended installation.
  - .4 Pump performance and efficiency curves.
  - .5 ASME Certification (for all heaters over 600mm (24") in diameter)

**1.3            CLOSEOUT SUBMITTALS**

- .1 Provide maintenance and engineering data for incorporation into manual specified in general requirements
- .2 Data to include:
  - .1 Manufacturer's name, type, model year, capacity, and serial number.
  - .2 Details of operation, servicing, and maintenance.
  - .3 Recommended spare parts list with names and addresses.

## **Part 2 Products**

### **2.1 WRDSB WATER HEATER**

- .1 The unit listed in the Schedules (or equivalent) shall be rented from Reliable. Coordinate with the administrative assistant at 519-570-0003 Ext 4432 to review and approve rental agreement. Fees (if any) shall be paid by the Owner directly to Reliable but all arrangements for rental, delivery, and receiving of the heater shall be made by the Mechanical contractor.
- .2 Mechanical contractor to include for installation complete with piping, venting, start-up, etc.
- .3 Water heater type and capacity as indicated.

### **2.2 GAS FIRED HIGH EFFICIENCY WATER HEATER**

- .1 To ANSI Z21.10.3/CSA 4.3 with a recovery rate of 674 l/h (178 gal/h) based on 56°C (100°F) rise and 44 kW (150 MBH) input. Efficiency of 98%.
- .2 Tank: 378 l (100 gal), glass, lined steel, 692 mm (27¼") dia x 1918 mm (75½") high fibreglass insulation, enameled steel jacket.
- .3 Gas burner: complete with high limit control, gas valve, gas pressure regulator, 100% safety shut-off, firepower gas burner with air distribution ring, 120V /1/60.
- .4 Vent kit complete with low profile termination kit.
- .5 Provide 100 mm (4") ULC S636 approved CPVC piping and fittings for combustion and exhaust. Install as per manufacturers recommendations. Support piping at 1.5 m maximum.
- .6 Provide neutralizing cartridge for each hot water tank as supplied by equipment manufacturer.
- .7 Tank to be ASME certified if over 600mm (24") in diameter.
- .8 Acceptable materials:
  - .1 A. O. Smith Cyclone XI BTH-150
  - .2 Ruud
  - .3 Bradford White

### **2.3 WATER HEATER TRIM AND INSTRUMENTATION**

- .1 Drain valve: NPS 25 mm (1") with hose end.
- .2 Thermometer: 100 mm (4") dial type with red pointer and thermowell filled with conductive paste.
- .3 Thermowell filled with conductive paste for control valve temperature sensor.
- .4 ASME rated temperature and pressure relief valve sized for full capacity of heater, having discharge terminating over floor drain and visible to operators.
- .5 Magnesium anodes adequate for 20 years of operation and located for easy replacement.

**Part 3                    Execution**

**3.1                    WATER HEATER**

- .1        Install in accordance with manufacturer's recommendations and authority having jurisdiction.
- .2        Provide structural steel for horizontal (vertical) mounted tanks.
- .3        Provide insulation between tank and supports.
- .4        Provide neutralizing cartridge on each vent drain.
- .5        Install oil burning domestic water heaters in accordance with CAN/CSA B139.
- .6        Install natural gas or propane gas fired domestic water heaters in accordance with CSA-B149.1-00.

**3.2                    FIELD QUALITY CONTROL**

- .1        Manufacturer's factory trained, certified Engineer to start up and commission DHW heaters.
- .2        Check power supply.
- .3        Check starter protective devices.
- .4        Start up, check for proper and safe operation.
- .5        Check settings and operation of all hand-off-auto selector switch, operating, safety and limit controls, audible and visual alarms, over-temperature and other protective devices.
- .6        Demonstrate equipment operation as directed by consultant.

**3.3                    WARRANTY**

- .1        Warranty Start Date:
  - .1        Warranty period starts as of the date of Ready for Takeover.
  - .2        Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2        Warranty Duration:
  - .1        Gas fired high efficiency water heater: three (3) year warranty certificate.
  - .2        Gas fired water heater (power vent): three (3) year warranty certificate.
  - .3        Gas fired water heater (atmospheric): three (3) year warranty certificate.
  - .4        Domestic hot water heater and storage tank: extended warranty: ten (10) years. Provide certificate.
- .3        Warranty Coverage:
  - .1        Applies to parts and labour.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.

**1.2            SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with general requirements.
- .2 Indicate:
  - .1 Equipment, including connections, fittings, control assemblies and ancillaries, identifying factory and field assembled.
  - .2 Wiring and schematic diagrams.
  - .3 Dimensions and recommended installation.
  - .4 Pump performance and efficiency curves.

**1.3            CLOSEOUT SUBMITTALS**

- .1 Provide maintenance and engineering data for incorporation into manual specified in general requirements
- .2 Data to include:
  - .1 Manufacturer's name, type, model year, capacity, and serial number.
  - .2 Details of operation, servicing, and maintenance.
- .3 Recommended spare parts list with names and addresses.

**Part 2            Products**

**2.1            DOMESTIC HOT WATER EXPANSION TANK**

- .1 Pre-charged 6.4 gal (3.2 gal accept volume) hydropneumatic steel expansion tank complete with internal butyl diaphragm.
- .2 Tank construction shall be in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code, with all welds conforming to ASME Section IX. The tank must be stamped with a maximum working pressure of 150 psi and a maximum working temperature of 250°F.
- .3 Tank volume: 24 l (4.5 gallons) with 0.73 acceptance factor.
- .4 Acceptable material:
  - .1 Amtrol ST-12C
  - .2 Well-X-Trol



## **2.2 DOMESTIC HOT WATER CIRCULATING PUMPS**

- .1 Capacity: as indicated.
- .2 Construction: closed-coupled, in-line centrifugal, all bronze construction, stainless steel shaft, stainless steel or bronze shaft sleeve, two oil lubricated bronze sleeves or ball bearings. Design for 105°C (220°F) continuous service.
- .3 Motor: drip-proof, with thermal overload protection.
- .4 Supports: provide as recommended by manufacturer.
- .5 Acceptable materials:
  - .1 Bell & Gossett
  - .2 Armstrong
  - .3 Taco

## **2.3 THERMOSTATIC WATER CONTROLLER (3 Port)**

- .1 Thermostatic controller with swivel action check stops, removable cartridge with strainer, stainless steel piston and liquid fill thermal motor with bellows mounted out of water. Volume control shut off valve, bimetal dial thermometer (3" face, range 20° – 240°F), brass pipe, fittings and unions. Standard valve and piping finish is rough bronze.
- .2 Acceptable materials:
  - .1 Symmons 7-1000A-ASB-W
  - .2 Powers

## **Part 3 Execution**

### **3.1 RECIRCULATING PUMP**

- .1 Make piping and electrical connections to pump and motor assembly and controls as indicated.
- .2 Ensure pump and motor assembly do not support piping.

### **3.2 DOMESTIC HOT WATER EXPANSION TANK**

- .1 Adjust expansion tank pressure to suit system pressure.
- .2 Provide an expansion tank on the cold water feed to each water heater complete with lockshield type shutoff valve at inlet to tank.
- .3 Provide an expansion tank at the water entrance.

### **3.3 FIELD QUALITY CONTROL**

- .1 Manufacturer's factory trained, certified Engineer to start up and commission DHW heaters.
- .2 Check power supply.
- .3 Check starter protective devices.

- .4 Start up, check for proper and safe operation.
- .5 Check settings and operation of all hand-off-auto selector switch, operating, safety and limit controls, audible and visual alarms, over-temperature and other protective devices.
- .6 Adjust flow from water-cooled bearings.
- .7 Adjust impeller shaft stuffing boxes, packing glands.
- .8 Demonstrate equipment operation as directed by consultant.
- .9 Demonstrate water softener regeneration controls.

### **3.4 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**

**Part 1 General**

**1.1 GENERAL REQUIREMENTS**

- .1 Conform to Sections of Division 1 and to General Mechanical Requirements Section.

**1.2 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 Perform work in accordance with the recommendations of and the requirements of:
  - .1 Local and district bylaws and regulations.
  - .2 N.F.P.A.14 "Installation of Standpipe and Hose Systems".
  - .3 The Ontario Building Code.
  - .4 U.L.C. or Factory Mutual approval for hose, valve and extinguisher requirements.
  - .5 N.F.P.A.10 "Standard for Portable Fire Extinguishers".
  - .6 The Ontario Fire Code.

**1.3 SUBMITTALS**

- .1 Submit shop drawings and maintenance data in accordance with general requirements.

**1.4 COORDINATION**

- .1 Confirm fire extinguisher cabinet locations and quantities from both architectural and mechanical drawings and report any discrepancies to consultant prior to bid close.
- .2 Coordinate location of cabinet with other trades and provide protection against damage during construction.

**Part 2 Products**

**2.1 MULTI-PURPOSE DRY CHEMICAL EXTINGUISHERS (CLASS ABC)**

- .1 Stored pressure rechargeable type with hose and shut off nozzle, ULC labelled for A, B and C class protection as indicated. Size of extinguishers shall be as follows:
  - .1 Kitchen Type 'K' 10 lb 20BC rating
  - .2 Servery Areas Type 'K' 10 lb 20 BC rating
  - .3 Mechanical Rooms 10 lb ABC rating
  - .4 Storage Rooms 10 lb ABC rating
  - .5 Corridor/Gym/Finished Areas 5 lb ABC rating complete with cabinet
  - .6 Acceptable materials:
    - .1 Wilson & Cousins
    - .2 National

## **2.2 CABINETS**

- .1 Recessed mounted type of a size sufficient to contain all necessary components. Tub to be constructed of 1.5 mm (16 gauge) steel and finished with Wilco "Pro-Tech" Premier white painted finish. Adjustable frame comprising of 180° opening door and trim to be separate assembly adaptable to any type of finished wall. Trim to have 6 mm (1/4") return on outer edges with full length semi-concealed piano hinge, and Corbin style latching device.
- .2 Doors and trim to be 1.5 mm (16 gauge) white painted finish. Door glass to be 6 mm (1/4") Duo Lite Safety Glass.
- .3 Cabinet to maintain fire resistive rating of construction in which they occur.
- .4 Do not provide cabinets for mechanical room and service area fire extinguishers unless indicated.
- .5 Acceptable material:
  - .1 Wilson & Cousins Model IE - 105R (5 and 10 lb. Class)
  - .2 National

## **2.3 IDENTIFICATION**

- .1 Identify extinguishers in accordance with recommendations of NFPA 10.
- .2 Attach tag or label to extinguishers indicating month and year of installation and provide space for the addition of recording service dates.

## **2.4 FIRE BLANKET**

- .1 100% non-combustible fire retardant glass fibre, non-toxic, non-conductor, cleanable complete with straps.
- .2 Size: 1 m x 1 m (40" x 40").
- .3 Cabinet to be surface mounted, 400 mm x 300 mm (16" x 12").
- .4 Mount on wall in kitchen area or directed on site by consultant.
- .5 Manufacturer:
  - .1 National FB 4040 blanket, FB 6078 MC cabinet.
  - .2 Wilson & Cousins.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Provide portable fire extinguisher cabinets and mount in wall during construction. Cabinet to be surface or recessed mounted as indicated on the drawings. Install cabinets so that the door will not obstruct normal traffic when open.
- .2 Hang extinguishers in cabinets with wall mounting bracket.

- .3 Prior to installing the extinguisher cabinets, confirm the mounting height and exact location with the Consultant. Mount extinguisher so top of unit is not more than 1.5 m (5').
- .4 Install wall mounted fire extinguishers complete with wall mounting bracket where indicated and/or directed on site by consultant.
- .5 Caulk perimeter of fire extinguisher cabinets after acceptance.

### **3.2 TESTS**

- .1 Fire protection equipment shall be tested to the requirements of NFPA10, NFPA13, NFPA14 and comply with the requirements of the authorities having jurisdiction.

### **3.3 FIRE BLANKET**

- .1 Hang blanket on wall in cabinet as indicated, to manufacturers' recommendations.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 CAN/CSA B45S1, Supplement #1 to CAN/CSA B-45 Series Plumbing Fixtures.
- .3 CAN/CSA-B45 Series, CSA Standards on Plumbing Fixtures.
- .4 CAN/CSA-B125.3, Plumbing Fittings.
- .5 CAN/CSA-B651, Accessible Design for the Built Environment.

**1.2 SHOP DRAWINGS**

- .1 Submit shop drawings and product data in accordance with general requirements.
- .2 Indicate, for all fixtures and trim:
  - .1 Dimensions, construction details, roughing-in dimensions.
  - .2 Factory-set water consumption per flush at recommended pressure.
  - .3 For water closets, urinals: minimum pressure required for flushing.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance data including monitoring requirements for incorporation into manual specified in general requirements.
- .2 Include:
  - .1 Description of fixtures and trim, giving manufacturer's name, type, model, year, capacity.
  - .2 Details of operation, servicing, maintenance.
  - .3 List of recommended spare parts.

**1.4 PRODUCTS INSTALLED BUT NOT SUPPLIED UNDER THIS SECTION**

- .1 Install rough-in for equipment supplied by others, complete with valves on hot and cold water supplies, waste and vent.
- .2 Equipment installed by others.
  - .1 Connect with unions.
- .3 Equipment not installed.
  - .1 Capped with valves for future connection by others.

**Part 2                      Products**

**2.1                      MANUFACTURED UNITS**

- .1        Fixtures: manufacture in accordance with CAN/CSA-B45 series.
- .2        Trim, fittings: manufacture in accordance with CAN/CSA-B125.3.
- .3        Exposed plumbing brass to be chrome plated.
- .4        Number, locations: Architectural drawings to govern.
- .5        Fixtures in any one location to be product of one manufacturer and of same type.
- .6        Trim in any one location to be product of one manufacturer and of same type.

**2.2                      PLUMBING FIXTURES**

**.1                      WATER CLOSET (WC- 1) (Flush Valve)**

- .1        Floor mounted, top spud, ultra-low flush, maximum 6 litres (1.6 gal)/flush.
- .2        Bowl: vitreous china, siphon jet, elongated rim.
  - .1        Acceptable materials:  
            American Standard Madera Flowise  
            Crane  
            Kohler
- .3        Flush valve: exposed, polished chrome, diaphragm type with NPS 25 mm (1") screwdriver angle stop, flush connection and coupling for NPS 40 mm (1½") top spud, wall and spud escutcheons, seat bumper and vacuum breaker. Ultra low flush cycle:
  - .1        Acceptable materials:  
            Delta Teck 81T201  
            Sloan  
            Zurn
- .4        Seat: white, elongated, open front, moulded solid plastic, less cover, stainless steel check hinges, stainless steel or solid brass insert post.
  - .1        Acceptable materials:  
            Centoco AM500STSCSS  
            Bemis  
            Olsonite
- .5        Provide floor flange with rubber gasket.

**.2 BARRIER FREE WATER CLOSET (WC- 2) (Flush Valve)**

- .1 Floor-mounted, flush valve, for barrier free use.
- .2 Top of seat to be between 400 mm (16") and 460 (18 2/5") mm from finished floor.
- .3 Bowl: vitreous china, floor mounted, syphon jet, elongated rim, top spud for flush valve, bolt caps.
  - .1 Acceptable materials:  
American Standard Madera  
Crane  
Koehler
- .4 Flush valve: exposed, polished chrome, single flush, diaphragm type with NPS 25 mm (1") screwdriver angle stop, oscillating handle, flush connection and coupling for NPS 40 mm (1 1/2") top spud, wall and spud escutcheons, seat bumper, and vacuum breaker. Ultra low flush cycle.
  - .1 Acceptable materials:  
Delta 81T201  
Sloan  
Zurn
- .5 Seat: white, elongated, open front with cover, molded solid plastic, cover, stainless steel check hinges, stainless steel or solid brass insert post.
  - .1 Acceptable materials:  
Centoco 820STS  
Bemis  
Olsonite
- .6 Secure wall plate above flush valve.
- .7 Provide floor flange with rubber gasket.

**.3 WATER CLOSET (WC-3) (Flush Tank) (Kindergarten)**

- .1 Floor-mounted, flush tank, round front.
- .2 Bowl: vitreous china, siphon jet, close-coupled combination, bowl and bolt caps.
- .3 Closet tank: vitreous china with tank liner, flapper type flush valve assembly (for ultra low flush cycle: adjustable from 3.8 - 17 litres (1.0 - 4.5 gal)/flush, factory set to 13.25 litres (3.5 gal)/flush).
  - .1 Acceptable materials:  
American Standard Cadet Pro  
Kohler  
Crane Radcliffe
- .4 Seat: white, round, open front, moulded solid plastic with cover, stainless steel check hinges, stainless steel or solid brass insert post.
  - .1 Acceptable materials:  
Centoco 460STS  
Bemis  
Olsonite
- .5 Provide floor flange with rubber gasket.



**.4 WATER CLOSETS (WC- 4) DAYCARE (Flush Tank)**

- .1 Floor-mounted, flush tank, round front.
- .2 Bowl: vitreous china, siphon jet, round front rim, close-coupled combination, bowl and bolt caps.
- .3 Closet tank: vitreous china with tank liner, flush valve assembly (for ultra low flush cycle: factory set to 6 litres (1.3 gal)/flush).
  - .1 Acceptable materials:
    - .1 American Standard Cadet Pro
    - .2 Crane
    - .3 Kohler
- .4 Seat: white, regular, closed front, moulded solid plastic, with cover, potty training seat with magnetic latch to lid, stainless steel check hinges, stainless steel or solid brass insert post.
  - .1 Acceptable materials:
    - .1 Bemis Next Step 483SLOW
    - .2 Olsonite
- .5 Provide floor flange with rubber gasket.

**.5 BARRIER FREE DRINKING FOUNTAIN BOTTLE FILLING STATION (DF-1) (Non Ref)**

- .1 Wall hung unit shall provide 8.0 gph of water. Shall provide 1-1.5 gpm flow rate with laminar flow to minimize splashing. Shall include antimicrobial protected plastic components to prevent mold and mildew. Bottle filling unit shall meet ADA guidelines for parallel approach. Unit shall meet ADA guidelines for frontal or parallel approach. Unit shall be lead-free design which meets Safe Drinking Water Act and is certified to NSF/ANSI 61 and California AB1953. Unit shall be certified to UL399 and CAN/CSA 22.2 No. 120 with wall plate, wall hanger and concealed floor mounted wall carrier. Complete with filter
- .2 Acceptable materials: Elkay LZWSSM

**.6 STAINLESS STEEL SINK SINGLE COMPARTMENT (S-1)**

- .1 Single compartment, ledge-back.  
From 1.0 mm (20 gauge) thick type 302 stainless steel, self-rimming, undercoated, clamps. Overall sizes: 520 mm x 510 mm x 180 mm (20"x20"x7").
  - .1 Acceptable materials:
    - Franke LBS 6807
    - Elkay
- .2 Trim: chrome plated brass, with 300 mm (12") swing spout, aerator, single lever handle, washerless controls, accessories to limit flow rate to 2 litres/minute at 413 kPa (60 psi).
  - .1 Acceptable materials:
    - Delta 100
    - Moen
    - Zurn

- .3 Waste fitting: integral stainless steel basket strainer/stopper, tailpiece, cast brass P-trap with cleanout.

**.7 LARGE STAINLESS STEEL SINK DOUBLE COMPARTMENT SINK (S-2)**

- .1 Double compartment, ledge back.  
From 1.2 mm (18 gauge) thick type 304 polished stainless steel, self-rimming, undercoated, clamps. Overall sizes: 794 mm x 522 mm x 254 mm (31 ¼" x 20 9/16" x 10").
  - .1 Acceptable materials:  
Franke LBD6410PCB-1
- .2 Trim: chrome plated brass, with 300 mm (12") swing spout, aerator, single lever handle, washerless controls, accessories to limit flow rate to 2 litres/minute at 413 kPa (60 psi).
  - .1 Acceptable materials:  
Delta 100  
Moen  
Zurn

**.8 STAINLESS STEEL TRIPLE COMPARTMENT SCULLERY SINK (S-3)**

- .1 Triple compartment, scullery sink, integral-backsplash.  
From 16 gauge, thick type 302 stainless steel. Overall sizes: 1610 mm x 690 mm x 860 mm (63½" x 27" x 34"). Exposed surfaces are polished satin finish. Radius coved bowls. Corner waste fitting. Backsplash drilled for 8" centre set.
  - .1 Acceptable materials:
    - .1 Novanni 7006
    - .2 Elkay
    - .3 Franke
- .2 Trim: chrome plated brass, with 200 mm (8") swing spout, aerator, two lever handle, washerless controls, accessories to limit flow rate to 2 litres/minute at 413 kPa (60 psi). Complete with self close pre-rinse spray with spring loaded stainless steel hose, add-on faucet with standard 8" tubular spout, accessories to limit flow rate to 5.7 litre/min, aerator.
  - .1 Acceptable materials:
    - .1 Delta 55C1583
    - .2 Moen
    - .3 Zurn
- .3 Waste fitting: integral stainless steel basket strainers/stoppers, tailpieces, cast brass P-traps with cleanouts.

**.9 WALL HUNG LAVATORY (L-1) (Electronic Faucet)**

- .1 Vitreous china, low shelf, with integral back, contoured front, shallow front basin, front overflow, soap depressions, supply openings on 102 mm (4") centres, concealed supports. Sizes: 635 mm x 540 mm (25" x 21½"). Suitable for wall mounted.

- .1 Acceptable materials:  
American Standard Murro  
Crane  
Kohler

- .2 Waste fitting: NPS 32 mm (1¼") offset waste with grid strainer.

- .3 Trim

Chrome plated brass electronic faucet, washerless, aerator, and deck plate, AC adaptor suitable for 120/1/60 (c/w hardwired transformer. Provide all required low voltage wiring to JB provided by electrician). Provide accessories to limit maximum flow rate to 8.35 l/min (2.2 gpm) at 413 kPa (60 psi).

- .1 Acceptable material:  
Delta 591T0228TR  
Moen  
Zurn

**.10 BARRIER-FREE WALL HUNG LAVATORY (L-2) (Electronic Faucet)**

- .1 Vitreous china, low shelf, with integral back, contoured front, shallow front basin, front overflow, knee guard, soap depressions, supply openings on 102 mm (4") centres, concealed supports. Sizes: 635 mm x 540 mm (25" x 21½"). Suitable for wall mounted.

- .1 Acceptable materials:  
American Standard Murro  
Crane  
Kohler

- .2 Waste fitting: NPS 32 mm (1¼") offset waste with grid strainer.

- .3 Trim

Chrome plated brass electronic faucet, washerless, aerator, and deck plate, AC adaptor suitable for 120/1/60 (c/w hardwired transformer. Provide all required low voltage wiring to JB provided by electrician). Provide accessories to limit maximum flow rate to 8.35 l/min (2.2 gpm) at 413 kPa (60 psi).

- .1 Acceptable material:  
Delta 591T0228TR  
Moen  
Zurn

- .4 Insulate waste and supplies with UL listed preformed insulation system complete with seamless jacket.

- .1 Acceptable materials:

- McGuire Prowrap

- Truebro

**.11 WALL HUNG LAVATORY (L-3) (Electronic Faucet)(Kindergarten/Daycare)**

- .1 Wall hung, integral back:

- .2 Vitreous china, with splash lip, soap depressions, supply openings on 100 mm (4") centres, overflow. Size 470 mm x 432 mm (18½" x 17").

- .1 Acceptable materials:

- American Standard Declyn

- Crane

- Kohler

- .3 Waste fitting: grid strainer.

- .4 Trim

Chrome plated brass electronic faucet, washerless, aerator, and deck plate, AC adaptor suitable for 120/1/60 (c/w hardwired transformer. Provide all required low voltage wiring to JB provided by electrician). Provide accessories to limit maximum flow rate to 8.35 l/min (2.2 gpm) at 413 kPa (60 psi).

- .1 Acceptable material:

- Delta 591T0228TR

- Moen

- Zurn

- .5 Insulate waste and supplies with UL listed preformed insulation system complete with seamless jacket.

- .1 Acceptable materials:

- McGuire Prowrap

- Truebro

- .6 Mount fixture at +/-600mm AFF to rim

**.12 GROUP WASH FOUNTAIN (WF-1)**

- .1 Wall mtd Barrier free terreon bowl, stainless steel panel suitable for three (3) users complete with floor mounted concealed wall carrier.

- .2 Trim: adaptive infra-red controlled, molded sprayhead, stop valves, transformer, horizontal swing check valves, thermostatic mixing valve preset at 40°C. Provide control to limit flow to 2l/minute. Suitable for 120/1/60.

- .3 Soap dispenser: Liquid mounted on sprayhead complete with 2 soap valves and vandal proof filler caps.

- .4 Colour: colour by architect. Allow for two (2) premium colours.

- .5 Acceptable materials:

- Bradley Tri Fount MF2939

- .6 Mount at 600 mm above finished floor to rim.

**.13 WALL MOUNTED GROUP LAVATORY SYSTEM 2-PERSON (WF-2)**

- .1 Wall mounted Type 304 stainless steel suitable for three (3) users complete with backsplash and floor mounted concealed wall carrier.
  - .1 Acceptable materials:  
Acorn DSW380
- .2 Accessory description: provide trap enclosure. Insulate waste and supplies with ULC listed preformed insulation system complete with seamless jacket.
- .3 Trim: sensor operating faucet at each individual user, thermostatic mixing valve preset at 40°C chrome strainer, trap cover.

**.14 MOP SINKS (MS-1)**

- .1 Sink: moulded stone, 250 mm (10") high. Size: 600 mm x 600 mm x 250 mm (24" x 24" x 10").
  - .1 Acceptable materials:  
Fiat MSB2424  
Zurn  
Stern Williams
- .2 Supply fitting: with built-in elevated vacuum breaker, indexed cross handles, 1400 mm (54") long rubber hose, hose holder, mop hanger, escutcheons, union inlets, heavy cast brass spout with pail hook, aerator, brace to wall, integral stop valves. Provide accessories to limit maximum flow rate to 8.35 l/min (2.2 gpm) at 413 kPa (60 psi).
  - .1 Acceptable materials:  
Fiat 430-AA  
Moen  
Zurn
- .3 Waste fitting: 80 mm (3") chrome plated cast brass outlet strainer.
- .4 Wall guard:  
Stainless steel 600 mm (24") high continuous on adjacent walls.
- .5 Provide backflow preventor and 15 mm cold water line adjacent to mop receptor. Refer to detail.
- .6 Provide EW-1 eye wash adjacent to mop receptor. Refer to detail.

**.15 EMERGENCY EYE WASH (EW-1)**

- .1 250 mm (10") diameter yellow impact resistant bowl chrome plated brass spray heads complete with covers, and wall mounting bracket.
- .2 Tepid water mixing valve meeting requirements of ANSI standard Z358.1. Mixing valve is to provide water temperature between 15.5°C (60°) and 38°C (100°F).
- .3 15 mm (1/2") chrome plated brass stay open ball valve complete with push handle.
- .4 Provide liquid filled temperature dial at output of thermostatic mixing valve.

- .5 Acceptable materials:
  - Haws 7260BT and Mixing Valve TWBS-EWE
  - Bradley
  - Guardian

**.16 WASHER SUPPLY (WS-1)**

- .1 Encased Washing Machine Valve.
- .2 P. V. C. casing 159 mm x 194 mm x 219 mm (6 1/3" x 7 3/4" x 8 3/4") deep.
- .3 Single lever handle valve with 20 mm (3/4") hose connection, vacuum breaker.
- .4 Knockout for standpipe.
- .5 Acceptable material:
  - Zurn – WM-2961

**2.3 FIXTURE CARRIERS**

- .1 Provide factory manufactured floor-mounted carrier systems for all wall-mounted fixtures.
- .2 Acceptable materials:
  - .1 Zurn
  - .2 Smith
  - .3 Ancon

**2.4 PLUMBING FIXTURES**

- .1 Refer to plumbing fixture schedule on the drawings for fixture type, manufacturer, trim, drainage supply, and accessories.

**2.5 FIXTURE PIPING**

- .1 Hot and cold water supplies to each fixture/faucet:

Chrome plated flexible supply pipes each with screwdriver stop, reducers, escutcheon and chrome plated nipple.

  - .1 Acceptable materials:
    - .1 Delta 47T900 Series
    - .2 McGuire
- .2 Waste:

Open grid strainer, or pop up as indicated, offset open grid strainer on Barrier-Free fixtures, cast brass fittings with tubular piping, chrome plated, rubber gasket compression fitting, and overflow flange.

  - .1 Acceptable materials:
    - .1 Delta 33T200 Series
    - .2 McGuire

- .3 'P' Traps:
  - Cast brass P trap with cleanout on each fixture not having integral trap.
  - Chrome plated in all exposed places.
- .1 Acceptable materials:
  - .1 Delta 33T300 Series
  - .2 McQuire

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 Mounting heights:
  - .1 Standard: to comply with manufacturer's recommendations unless otherwise indicated or specified. Confirm mounting height(s) with consultant prior to rough-in.
  - .2 Wall-hung fixtures: measured from finished floor.
  - .3 Physically Barrier-Free: to comply with most stringent of either NBCC or CAN/CSA B651.
- .2 Drinking fountains:
  - .1 In accordance with CAN/CSA B45S1.

#### **3.2 ADJUSTING**

- .1 Conform to water conservation requirements specified this section.
- .2 Adjustments.
  - .1 Adjust water flow rate to design flow rates.
  - .2 Adjust pressure to fixtures to ensure no splashing at maximum pressures.
  - .3 Adjust flush valves to suit actual site conditions.
  - .4 Adjust urinal flush timing mechanisms.
  - .5 Adjust water cooler, drinking fountain flow stream to ensure no spillage.
  - .6 Automatic flush valves for water closets and urinals: set controls to prevent unnecessary flush cycles during silent hours.
- .3 Checks.
  - .1 Water closets, urinals: flushing action.
  - .2 Aerators: operation, cleanliness.
  - .3 Vacuum breakers, backflow preventors: operation under all conditions.
  - .4 Wash fountains: operation of flow-actuating devices.
  - .5 Refrigerated water coolers: operation, temperature settings.
- .4 Thermostatic controls.
  - .1 Verify temperature settings, operation of control, limit and safety controls.

- .5 Floor and wall mounted fixtures: caulk to floor or wall using silicone caulking to make water tight, colour to match fixture.
- .6 Counter mounted fixtures: lay fixtures into bead of caulking to ensure excess moisture does not reach the cut edge of the countertop. Clean excess caulking off outside the sink.

**END OF SECTION**



**Part 1            General**

**1.1            GENERAL PROVISIONS**

- .1      This section covers items common to all sections of Heating, Ventilation, and Air Conditioning (HVAC) Division.
- .2      Conform to Division 1 General Conditions.
- .3      Furnish labour, materials, and equipment necessary for completion of work as described in contract documents.
- .4      Unless specifically indicated, all materials and equipment provided under this contract shall be new and shall be manufactured in the project year.
- .5      The term “Mechanical Contractor” shall remain active and shall mean a “single contractor” performing plumbing, drainage, heating, cooling, ventilation, and control services.
- .6      When quoting as a subcontractor this building contractor shall explicitly state the services they are providing i.e. Mechanical (all services), Plumbing (water and drainage systems) or HVAC (including hydronic and air systems).
- .7      Contractors shall be explicit to identify whether Fire Protection is included or omitted from the mechanical scope.

**1.2            INTENT**

- .1      Mention herein or indication on Drawings of articles, materials, operations or methods requires: supply of each item mentioned or indicated, of quality, or subject to qualifications noted; installation according to conditions stated: and, performance of each operation prescribed with furnishing of necessary labour, equipment, and incidentals for HVAC work.
- .2      Where used, words “Section” and “Division” shall also include other Subcontractors engaged on site to perform work to make building and site complete in all respects.
- .3      Where used, word “supply” shall mean furnishing to site in location required or directed complete with accessory parts.
- .4      Where used, word “install” shall mean secured in place and connected up for operation as noted or directed.
- .5      Where used, word “provide” shall mean supply and install as each is described above.

**1.3            REGULATIONS, PERMITS, AND FEES**

- .1      All materials and quality of work shall meet all current and latest Provincial, Municipal and Fire Marshall requirements, regulations, codes, and by-laws in force in the area of the project.

- .2 Each contractor shall give all necessary notices, obtain all necessary permits, and pay all fees in order that the work shown or specified may be carried out. Each contractor shall furnish any certificates necessary as evidence that the work installed conforms with the laws and regulations of all authorities having jurisdiction.
- .3 In the event that changes, or alterations are required on completed work by authorized inspectors, these changes shall be made at the contractor's expense.
- .4 Special equipment which does not have a standard CSA label shall be inspected by the local electrical authority having jurisdiction and the Approval Certificate shall be submitted to the Consultant as soon as possible. All costs and fees for inspections shall be borne by this contractor.

#### **1.4 DRAWINGS**

- .1 The drawings and this specification have been assembled together as a responsibility of the consultant. The same is true for the other consultants, i.e. architect, structural engineer, civil engineer, fire protection engineer, electrical engineer, etc.
- .2 The drawings and specifications are not assembled together for responsibility/division between subcontractors. The division of work between subcontractors remains the responsibility of the buildings' contractor (also known as the prime contractor or general contractor).
- .3 All subcontractors are encouraged to perform work amicably utilizing all of the drawings and specifications published by all of the consultants.
- .4 Plumbing and HVAC Drawings do not show structural and related details. Take information involving accurate measurement of building from building drawings, or at building. Make, without additional charge, any necessary changes, or additions to runs of piping, conduits, and ducts to accommodate structural conditions. Location of pipes, ducts, conduits and other equipment may be altered by Consultant without extra charge provided change is made before installation and does not necessitate major additional material.
- .5 As work progresses and before installing piping, ductwork, heating units, registers, diffusers, fixtures and any other fittings and equipment which may interfere with interior treatment and use of building, provide detail drawings, or obtain directions for exact location of such equipment and fitments.
- .6 Plumbing and HVAC drawings indicate general location and route of pipes, ducts and conduits which are to be installed. Where required work is not shown or only shown diagrammatically, install same at maximum height in space to conserve head room (minimum 2200 mm (88") clear) and interfere as little as possible with free use of space through which they can pass. Follow building lines, conceal piping, conduits and ducts in furred spaces, ceilings and walls unless specifically shown otherwise. Install work close to structure so furring will be small as practical.
- .7 Install piping and ductwork to clear structural members and any fireproofing. Locate HVAC work to permit installation of specified insulation. Do not remove or damage structural fireproofing. Leave space to permit fireproofing and insulation to be inspected and repaired.

- .8 Before commencing work, check and verify all sizes, locations, grade and invert elevations, levels, and dimensions to ensure proper and correct installation. Verify existing/municipal services.
- .9 Locate all HVAC and electrical equipment in such a manner as to facilitate easy and safe access to and maintenance and replacement of any part.
- .10 In every place where there is indicated space reserved for future or other equipment, leave such space clear, and install piping and other work so that necessary installation and connections can be made for any such apparatus. Obtain instructions whenever necessary for this purpose.
- .11 Relocate equipment and/or material installed but not co-ordinated with work of other Sections and/or installed incorrectly as directed, without extra charge.
- .12 Where drawings are done in metric and product not available in metric, the corresponding imperial trade size shall be utilized.

#### **1.5 INTERFERENCE AND COORDINATION DRAWINGS**

- .1 Prepare interference and equipment placing drawings to ensure that all components will be properly accommodated within the constructed spaces provided.
- .2 Prepare drawings to indicate co-ordination and methods of installation of a system with other systems where their relationship is critical. Ensure that all details of equipment apparatus, and connections are coordinated.
- .3 Ensure that clearances required by jurisdictional authorities and clearances for proper maintenance are indicated on drawings.
- .4 Upon consultant's request submit copies of interference drawings to consultant.
- .5 Due to the nature of the building and the complexity of the building systems provide the following:
  - .1 Interference drawings, showing coordination of architectural, structural, plumbing, HVAC, and electrical systems for the consultant's review prior to fabrication.
  - .2 Detailed layout drawings, clearly showing fasteners and hangers.
- .6 Provide CAD drawings (minimum file version AutoCAD 2013) in addition to hard copies.

#### **1.6 QUALITY ASSURANCE**

- .1 Perform work in accordance with applicable provisions of local plumbing code, gas ordinances, and adoptions thereof for all HVAC systems. Provide materials and labor necessary to comply with rules, regulations, and ordinances.
- .2 In case of differences between building codes, provincial laws, local ordinances, utility company regulations, and Contract Documents, the most stringent shall govern. Promptly notify Consultant in writing of such differences.

## **1.7 ALTERNATES AND SUBSTITUTIONS**

- .1 Throughout HVAC Division are lists of “Alternate Equipment” manufacturers acceptable to Consultant if their product meets characteristics of specified described equipment. Submitted Bids shall be based on the supply of named articles and or products as specified in the Bid Documents.
- .2 When two or more suppliers/manufacturers are named in the Bid Documents, only one supplier/manufacturer of the products named will be acceptable; however, it is the responsibility of this Division to ensure “Alternate Equipment” fits space allocated and gives performance specified. If an “Alternate Equipment” nor “equal” specified product unit is proposed and does not fit space allotted in Consultant’s opinion, supply of specified described equipment will be required without change in Contract amount. Should electrical characteristics for “alternate” or “equal” equipment differ from equipment specified it shall be the responsibility of the equipment manufacturer to pay all costs associated with the revisions to the electrical contract. Only manufacturers listed will be accepted for their product listing. All other manufacturers shall be quoted as substitution stating conditions and credit amount.
- .3 If item of material specified is unobtainable submit question during tender period.
- .4 If pipe or item, of size or weight indicated, is unobtainable, supply next larger size or heavier weight without additional charge.

## **1.8 EXAMINATION**

- .1 Site Reviews
  - .1 Examine premises to understand conditions, which may affect performance of work of this Division before submitting proposals for this work.
  - .2 No subsequent allowance for time or money will be considered for any consequence related to failure to examine site conditions.
- .2 Drawings:
  - .1 Plumbing and HVAC Drawings show general arrangement of piping, ductwork, equipment, etc. Follow as closely as actual building construction and work of other trades will permit.
  - .2 Consider Architectural and Structural Drawings part of this work insofar as these drawings furnish information relating to design and construction of building. These drawings take precedence over Plumbing, HVAC, and Fire Protection Drawings.
  - .3 Because of small scale of Drawings, it is not possible to indicate all offsets, fittings, and accessories, which may be required. Investigate structural and finish conditions affecting this work and arrange work accordingly, providing such fittings, valves, and accessories required to meet conditions.

- .3 Ensure that items to be furnished fit space available. Make necessary field measurements to ascertain space requirements including those for connections and furnish and install equipment of size and shape so final installation shall suit true intent and meaning of Contract Documents. If approval is received by Addendum or Change Order to use other than originally specified items, be responsible for specified capacities and for ensuring that items to be furnished will fit space available.

## **1.9 SEQUENCING SCHEDULING AND COORDINATION**

- .1 It is understood that while Drawings are to be followed as closely as circumstances permit, this Division will be held responsible for installation of systems according to the true intent and meaning of Contract Documents. Anything not clear or in conflict will be explained by making application to Consultant. Should conditions arise where certain changes would be advisable, secure Consultant's approval of these changes before proceeding with work.
- .2 Coordinate work of various trades in installing interrelated work. Before installation of HVAC items, make proper provision to avoid interferences in a manner approved by Consultant. Each Contractor shall refer to all sections of the specification for their responsibilities with other trades. Changes required in work specified in HVAC Division caused by neglect to do so shall be made at no cost to Owner.
- .3 Arrange pipes, ducts, and equipment to permit ready access to valves, unions, traps, starters, motors, control components, and to clear openings of doors and access panels.
- .4 Furnish and install inserts and supports required by HVAC Division unless otherwise noted. Furnish sleeves, inserts, supports, and equipment that are an integral part of other Divisions of the Work to Sections involved in sufficient time to be built into construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne by HVAC Division.
- .5 Be responsible for required excavation, backfilling, cutting, and patching incident to work of this Division and make required repairs afterwards to satisfaction of Consultant. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses.
  - .1 Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
  - .2 Each Section of this Division shall bear expense of cutting, patching, repairing, and replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.
  - .3 Cutting, patching, repairing, and replacing pavements, sidewalks, roads, and curbs to permit installation of work of this Division is responsibility of Section installing work.

- .6 Adjust locations of pipes, ducts, equipment, fixtures, etc, to accommodate work from interferences anticipated and encountered. Determine exact route and location of each pipe and duct prior to fabrication.
  - .1 Make offsets, transitions, and changes in direction of pipes, ducts, and electrical raceways as required to maintain proper head room and pitch of sloping lines whether or not indicated on Drawings.
  - .2 Furnish and install traps, air vents, sanitary vents, pull boxes, etc, as required to effect these offsets, transitions, and changes in direction.
- .7 Slots and openings through floors, walls, ceilings, and roofs shall be provided by this contractor but performed by a trade specializing in this type of work. This Division shall see that they are properly located and do any cutting and patching caused by its neglect to do so.

#### **1.10 REQUEST FOR INFORMATION (RFI) PROCEDURES**

- .1 RFIs shall be submitted to the consultant minimum two (2) weeks prior to answer being required. Failure to submit an RFI in a timely manner will forfeit delay claims and schedule extension requests by the contractor.
- .2 All RFIs will be submitted with the following information:
  - .1 RFI number
  - .2 Name of project
  - .3 Date of initiation
  - .4 Date response required by (minimum two (2) weeks)
  - .5 Subject
  - .6 Submitter's name
  - .7 Drawing/specification reference
  - .8 Photograph of the issue (if applicable)
  - .9 Description of the issue
  - .10 Contractor's proposed resolution

#### **1.11 CONTRACT BREAKDOWN**

- .1 Provide breakdown of contract exclusive of HST to acceptance of consultants prior to first draw submission.
- .2 Provide labour and material cost for each item.
- .3 Breakdown shall indicate total contract amount.
- .4 Contract breakdown shall be as follows as a minimum.
  - Mobilization and shop drawings
  - Demolition
  - Specialty Piping
  - Boilers
  - Reheat coils
  - Circulation pumps
  - Heating piping

Piping Insulation  
Ductwork  
Duct Insulation  
Grilles & Diffusers  
Fire Stopping  
Fans & Equipment  
HVAC system commissioning  
VRF/Heat Pump Equipment  
Building Automation Systems  
Testing Adjusting and Balancing  
Refrigeration Piping

- .5 Progress claims, when submitted are to be itemized against each item of the contract breakdown, this shall be done in table form showing contract amount, work complete to date, previous draw, amount this draw and balance.
- .6 **Mobilization amount may only be drawn when all required shop drawings have been reviewed by the consultant.**

#### **1.12 COMMISSIONING CONTRACT BREAKDOWN**

- .1 This contractor shall work with the HVAC system commissioning contractor as specified elsewhere. The following commissioning breakdown shall be indicated on the contract breakdown draw.

#### **1.13 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Furnish complete catalog data for manufactured items of equipment to be used in the Work to Consultant for review within 14 days after award of Contract.
- .2 Upon receipt of reviewed shop drawing, product is to be ordered immediately.
- .3 Provide a complete list of shop drawings to be submitted prior to first submission.
- .4 Before submitting to the Consultant, review all shop drawings to verify that the products illustrated therein conform to the Contract Documents. By this review, the Contractor agrees that it has determined and verified all field dimensions, field construction criteria, materials, catalogue numbers, and similar data and that it has checked and coordinated each shop drawing with the requirements of the work and of the Contract Documents. The Contractor's review of each shop drawings shall be indicated by stamp, date and signature of a qualified and responsible person possessing by the appropriate authorization.
- .5 If material or equipment is not as specified or submittal is not complete, it will be rejected by Consultant.
- .6 Additional shop drawings required by the contractor for maintenance manuals, site copies etc., shall be photocopies of the "reviewed" shop drawings. All costs to provide additional copies of shop drawings shall be borne by the contractor.
- .7 **Submit all shop drawings for the project as a package. Partial submittals will not be accepted.**

- 
- .8 Catalog data or shop drawings for equipment, which are noted as being reviewed by Consultant or their Engineer shall not supersede Contract Documents.
  - .9 Review comments of Consultant shall not relieve this Division from responsibility for deviations from Contract Documents unless Consultant's attention has been called to such deviations in writing at time of submission, nor shall they relieve this Division from responsibility for errors in items submitted.
  - .10 Check work described by catalog data with Contract Documents for deviations and errors.
  - .11 Shop drawings and product data shall show:
    - .1 Mounting arrangements.
    - .2 Operating and maintenance clearances. e.g., access door swing spaces.
  - .12 Shop drawings and product data shall be accompanied by:
    - .1 Detailed drawings of bases, supports, and anchor bolts.
    - .2 Acoustical sound power data, where applicable.
    - .3 Points of operation on performance curves.
    - .4 Manufacturer to certify as to current model production.
    - .5 Certification of compliance to applicable codes.
  - .13 State sizes, capacities, brand names, motor HP, accessories, materials, gauges, dimensions, and other pertinent information. List on catalog covers page numbers of submitted items. Underline applicable data.
  - .14 Shop drawings shall be submitted electronically as per the following directions:
    - .1 Electronic Submissions:
      - .1 Electronically submitted shop drawings shall be prepared as follows:
        - .1 Use latest software to generate PDF files of submission sheets.
        - .2 Scanned legible PDF sheets are acceptable. Image files are not acceptable.
        - .3 PDF format shall be of sufficient resolution to clearly show the finest detail.
        - .4 PDF page size shall be standardized for printing to letter size (8.5"x11"), portrait with no additional formatting required by the consultant. Submissions requiring larger detail sheets shall not exceed 11"x17".
        - .5 Submissions shall contain multiple files according to section names as they appear in Specification.
        - .6 File names shall include consultant project number and description of shop drawing section submitted.
        - .7 Each submission shall contain an index sheet listing the products submitted, indexed in the same order as they appear in the Specification. Include associated PDF file name for each section.



- .8 On the shop drawing use an “electronic mark” to indicate what is being provided.
- .9 **Each file shall bear an electronic representation of the “company stamp” of the contractor. If not stamped the file submission will not be reviewed.**
- .2 Email submissions shall include subject line to clearly identify the consultants project number and the description of the shop drawings submitted.
- .3 Electronic attachments via email shall not exceed 10MB. For submissions larger than 10MB, multiple email messages shall be used. Denote related email messages by indicating “1 of 2” and “2 of 2” in email subject line for the case of two messages.
- .4 Electronic attachments via web links (URL) shall directly reference PDF files. Provide necessary access credentials within link or as username/password clearly identified within body of email message.
- .5 On site provide one copy of the “reviewed” shop drawings in a binder as noted above.
- .6 Contractor to print copies of “reviewed” shop drawings and compile into maintenance manuals in accordance with requirements detailed in this section.

#### **1.14 EQUIPMENT NAMEPLATE DATA**

- .1 Between the manufactures design published literature, the shop drawing submission literature, and the nameplate data on the equipment, they can all read differently.
- .2 Most of the confusion and differences are coming out of the electrical power installation.
- .3 The contractors installing and connecting the equipment are responsible for the coordination of this data through the construction period.
- .4 The contractors shall share and/or request this information through out the project and monitor/make adjustments, provide recommendations accordingly based on any discrepancies.
- .5 The contractors are responsible for any cost associated with the changing data.
- .6 The final installation must meet the “Nameplate Data” on the equipment on site.

#### **1.15 OPERATION AND MAINTENANCE MANUAL**

- .1 Provide operation and maintenance data for incorporation into manual as in submittals’ requirements.
- .2 Operation and maintenance manual to be approved by, and final copies deposited with, Consultant before final inspection.
- .3 Submit 1 copy of Operation and Maintenance Manual to Consultant for approval. Submission of individual data will not be accepted unless so directed by Consultant. Submission can be done electronically in pdf format or as a hardcopy.

- 
- .1 Electronic submission/pdf file is required to be bookmarked. Any submission received without bookmarking will be immediately returned as unacceptable.
  - .2 Hardcopy submission shall be in a three-ring binder (minimum 50 mm (2") ring) and labelled as 'Operation and Maintenance Manual' with project name and location. Dividers are to be used for binder organization.
  - .4 Make changes as required and re-submit as directed by Consultant.
  - .5 Operation data to include:
    - .1 Control schematics for each system including environmental controls.
    - .2 Description of each system and its controls.
    - .3 Description of operation of each system at various loads together with reset schedules and seasonal variances.
    - .4 Operation instruction for each system and each component.
    - .5 Description of actions to be taken in event of equipment failure.
    - .6 Valves schedule and flow diagram.
    - .7 Colour coding chart.
    - .8 Spare parts equipment list.
    - .9 Manufacturers standard or extended warranty information.
  - .6 Maintenance data shall include:
    - .1 Servicing, maintenance, operation, and trouble-shooting instructions for each item of equipment.
    - .2 Data to include schedules of tasks, frequency, tools required and task time.
  - .7 Performance data to include:
    - .1 Equipment manufacturer's performance data sheets with point of operation as left after commissioning is complete.
    - .2 Equipment performance verification test results.
    - .3 Special performance data as specified elsewhere.
    - .4 Testing, adjusting and balancing reports as specified in Testing, Adjusting and Balancing Section.
    - .5 Copy of all substantial performance final certificates.
  - .8 Miscellaneous data to include:
    - .1 Letter of contractor's warranty and guarantee.
    - .2 Index sheet.
    - .3 Tabbed format for each section.
    - .4 Manufacturers approved shop drawings.
    - .5 Spare parts list and source.
    - .6 List of Manufacturers and suppliers address for each piece of equipment.

- .9 Final Submittals:
  - .1 Upon acceptance of Operation and Maintenance Manual by the Consultant provide the following:
    - .1 Provide two (2) copies of final operation maintenance manuals, as well as a PDF file of the entire approved manual on a USB stick. Only one USB stick is to be provided containing both the approved manual and as-built drawings.

#### **1.16 AS-BUILT DRAWINGS**

- .1 Site records:
  - .1 Contractor shall provide 2 sets of reproducible HVAC drawings. Provide sets of white prints as required for each phase of the work. Mark thereon all changes as work progresses and as changes occur. This shall include changes to existing HVAC systems, control systems and low voltage control wiring.
  - .2 On a weekly basis, transfer information to reproducibles, revising reproducibles to show all work as actually installed.
  - .3 Use different colour waterproof ink for each service.
  - .4 Make available for reference purposes and inspection at all times.
- .2 As-Built drawings:
  - .1 Prior to start of Testing, Adjusting and Balancing (TAB), finalize production of as-built drawings.
  - .2 Identify each drawing in lower right hand corner in letters at least 3 mm (1/8") high as follows: - "AS-BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW HVAC SYSTEMS AS INSTALLED" (Signature of Contractor) (date).
  - .3 TAB to be performed using as-built drawings.
    - .1 Submit hard copy to Consultant for approval. When returned, make corrections as directed.
    - .2 Once approved, submit completed reproducible paper as-built drawings as well as a scanned pdf file copy on USB stick with Operating and Maintenance Manuals.

#### **1.17 WARRANTIES**

- .1 In addition to guarantee specified in General Conditions, guarantee heating, cooling, and plumbing systems to be free from noise in operation that may develop from failure to construct system in accordance with Contract Documents.
- .2 Provide certificates of warranty for each piece of equipment made out in favor of Owner. Clearly record "start-up" date of each piece of equipment on certificate. Include certificates as part of Operation & Maintenance Manual.
- .3 If HVAC sub-contractor with offices located more than 80 km (50 miles) from Project site is used, provide service/warranty work agreement for warranty period with local HVAC sub-contractor approved by Consultant. Include copy of service/warranty agreement in warranty section of Operation & Maintenance Manual.

- .4 Contractor shall rectify any installation deficiencies in the boiler or pressurized other systems identified by a TSSA Inspector for a period of three (3) years from ready for takeover.
- .5 Warranty period shall start from date of ready for takeover.

#### **1.18 OCCUPANCY REQUIREMENTS**

- .1 The contractor shall provide the following documentation to the consultant's satisfaction prior to receiving occupancy. Failure to provide the proper documentation will result in the occupancy not being granted. List of required documentation:
  - .1 Final Certificates (required prior to consultant's release of conformance letter).
    - .1 Mandatory TSSA Gas Pressure Test (CSA B149.1)
    - .2 Seismic Restraint Engineers' Letter.
    - .3 TSSA report for new boiler/pressure vessel installation or written confirmation from TSSA that they opted to not inspect the system. (Low pressure systems that have either a wetted heating surface of 30 sq ft (2.89 sq m) or less, or a power rating of 100 MBH (30 kW) or less are exempt.
    - .4 Contractor letter verifying all refrigeration leak detection systems and their interlocks to downstream devices have been installed and tested.

#### **1.19 READY FOR TAKEOVER**

- .1 Complete the following to the satisfaction of the consultant prior to request for ready for takeover.
  - .1 As-Built Drawings.
  - .2 Maintenance Manuals
  - .3 System Start up
  - .4 TAB Reports
  - .5 HVAC System Commissioning
  - .6 Instructions to Owners

#### **1.20 REVISION TO CONTRACT**

- .1 Provide the following:
  - .1 Itemized list of material with associated costs.
  - .2 Labour rate and itemized list of labour for each item.
  - .3 Copy of manufacturers/supplier's invoice if requested.

#### **1.21 DELIVERY, STORAGE, AND HANDLING**

- .1 Follow Manufacturer's directions in delivery, storage, and protection, of equipment and materials. Contractor to include all costs associated with delivery storage and handling in tender price.

- .2 Deliver equipment and material to site and tightly cover and protect against dirt, water, and chemical or environmental damaging conditions but have readily accessible for inspection. Store items subject to moisture damage (such as controls) in dry, heated space.
- .3 Remove any damaged materials from the site.

#### **1.22 DESIGNATED SUBSTANCES AND HAZARDOUS MATERIALS**

- .1 **If designated substances and/or hazardous materials are suspected or identified cease all work in the immediate area in accordance with OHSA and notify consultant.**
- .2 **Each contractor and on site employee of the contractor shall have “asbestos awareness training”.**
- .3 The Contractor shall ensure that employees who may come into contact with designated substances and/or hazardous materials due to the nature of the work that they perform, have received training that enables them to recognize designated substances and/or hazardous materials and that enables them to react in accordance with the Occupational Health and Safety Act and regulations thereto should contact with designated substances and/or hazardous materials occur during the course of their work.
- .4 **It is the responsibility of the contractor to review the designated substances and/or hazardous materials book in the building prior to starting any work.**
- .5 **Existing occupied buildings (depending upon their age) may contain designated substances and/or hazardous materials in thermal insulating materials and some manufactured products, such as vinyl asbestos floor tile. Any insulating materials, on pipes, fittings, boilers, tanks, ductwork, etc. may contain designated substances and/or hazardous materials and shall not be disturbed.**
- .6 **A survey of each building documenting the location and condition of designated substances and/or hazardous materials -containing materials is available for your mandatory review prior to commencing any work on premises.**

#### **1.23 PHASING OF WORK**

- .1 This work for this project shall be constructed in phases. Refer to the architectural drawings for phasing information and details. Misinterpretation of the drawings with respect to the extent of the phasing of the work shall not relieve the contractor of the work required to complete the entire contract.
- .2 Provide all necessary services or temporary services to suit phasing of construction with respect to all HVAC services and fire protection.
- .3 Life safety systems in the building are to remain fully operational in occupied areas for building staff and occupants during renovations.
- .4 Provide all necessary tests and certificates at completion of each phase to suit requirements of local authorities and consultants for occupancy of completed areas.

**1.24 TSSA INSPECTION**

- .1 Prior to final completion of the project, this contractor shall make application, arrange, and pay for a TSSA inspection of all piping systems and equipment installations, including, but not limited to medical gasses, refrigeration, fuel piping, compressed air, heating plant, cooling plant, and associated equipment installed under the contract.
- .2 Provide a copy of the TSSA report in the maintenance manuals for each system.

**1.25 CONFINED SPACES**

- .1 Certain areas of the building may be defined as a “Confined Space”. Any personnel working in these areas must have confined space training, appropriate equipment and undertake all work in conformance with appropriate codes and standards.
- .2 Refer to building documentation for any spaces deemed “Confined Space”.

**1.26 ENERGY EFFICIENCY**

- .1 The HVAC systems of this building must achieve the energy efficiency levels by conforming to ANSI/ASHRAE/IESNA 90.1 “Energy Standard for Buildings Except Low-Rise Residential Buildings” and Chapter 2 of Division 3 of SB-10 prescriptive method from the Ontario Building Code.
- .2 All equipment, products, and installations must conform to the Codes and Standards.

**END OF SECTION**

**Part 1            General**

**1.1            TESTS**

- .1 Give 48 hours written notice of date for tests.
- .2 Insulate or conceal work only after testing and approval by Consultant.
- .3 Conduct tests in presence of Consultant.
- .4 Bear costs including retesting and making good.
- .5 Piping:
  - .1 General: maintain test pressure without loss for 4 h unless otherwise specified.
  - .2 Hydraulically test steam and hydronic piping systems at 1-1/2 times system operating pressure or minimum 860 kPa, whichever is greater.
  - .3 Test natural gas systems to CSA-B149.1-00, TSSA requirements and requirements of authorities having jurisdiction.
  - .4 Test fuel oil systems to CSA B139 1976, CSA B139S1-1982 and authorities having jurisdiction.**
- .6 Equipment: test as specified in relevant sections.
- .7 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures or test medium.

**1.2            SYSTEM START UP**

- .1 Provide adjusting testing and start up of all equipment prior to testing and balancing (TAB) specified elsewhere.**
- .2 Provide consultant with written notice verifying all equipment operation and installation is complete.**
- .3 Start up shall be in presence of the following: owner or representative, contractor, building automation systems (BAS) contractor, and manufacturer's representative. Each person shall witness and sign off each piece of equipment. Consultant's attendance will be determined by consultant.**
- .4 Simulate system start up and shut down and verify operation of each piece of equipment.
- .5 Arrange with all parties and provide 72 hours notice for start up procedure.
- .6 Arrange with building automation systems contractor to sequence all components and ensure system operation.

**1.3            COMMISSIONING**

- .1 Prepare, in writing, documentation of any deficiencies discovered during the commissioning process. Submit to consultant and Owner/Owner's Representative.**

- 
- .2 The Commissioning Process is detailed in *ASHRAE Guideline 1-1996 HVAC Commissioning Process*. The commissioning plan may be modified to reflect the actual construction schedule and design.**
  - .3 Provide a pre-functional test of all HVAC system and sub-system elements, including control devices, shall be checked for the following:**

    - .1 Verify that each element has been properly installed, properly identified, and that all connections (including electrical) have been made correctly.**
    - .2 Verify that each element has been checked for proper lubrication, drive rotation, belt tension, control sequence, flow direction, or other conditions which may cause damage or reduce system performance.**
    - .3 Verify that tests, meter readings, and specific HVAC/electrical performance characteristics agree with those required by equipment or system manufacturer.**
    - .4 Controls calibration to be completed in accordance with the specification.**
    - .5 The TAB shall be done in accordance with the specifications.**
  - .4 A functional performance testing shall be done during two separate periods – one during the cooling season and one during the heating season. The first (cooling) testing period shall occur as soon after completion of installation as practical. The heating testing period shall occur as soon as weather conditions make it practical to test warm-up, zone heating and economizer functions. These tests ensure that all equipment and systems operate in accordance with design intent. The tests are dynamic tests, and test the systems through all possible modes of operation.**
  - .5 Reports:**

    - .1 The contractor shall be responsible for recording, documenting, and maintaining detailed inspection and testing data on the test documentation reports. The data record shall be comprehensive and concise.**
    - .2 All data must be recorded as soon as possible during the course of the inspection and testing.**
    - .3 All documentation shall have the date, time, and names of persons participating in the inspection and testing.**
    - .4 All test instruments shall be documented for valid calibration.**
    - .5 The recording work sheets, inspection check lists, and Performance Testing plans must all be approved by the Engineer and the owner's representative prior to the start of the testing.**
    - .6 Include all commissioning documentation in the maintenance manuals.**
  - .6 HVAC System Execution:**

    - .1 Operate equipment and systems shall be tested in the presence of the owner's representative and the consultant to demonstrate compliance with specified requirements. To minimize the time of Commissioning Team members, testing shall be done in four seasonal single blocks of time insofar as possible.**
    - .2 Notify the consultant, in writing, fourteen (14) days prior to tests scheduled under requirements of this Section.**



- .3 Testing shall be conducted under specified design operating conditions as recommended or approved by the consultant.
- .4 All elements of systems shall be tested to demonstrate that total systems satisfy all requirements of these Specifications. Testing shall be accomplished on hierarchical basis. Test each piece of equipment for proper operation, followed by each sub-system, followed by entire system, followed by any inter-ties of other major systems.
- .5 All special testing materials and equipment shall be provided by the appropriate contractor.
- .6 Provide three copies of all test reports and records to the consultant.
- .7 The verification testing procedures shall address all operating characteristics of all HVAC equipment and systems, including:

**Equipment Checklist**

Boiler(s)  
Rooftop Heating/Cooling Unit(s)  
Exhaust Fans  
Pumps  
Controllers/Valves/Dampers  
Relays/Sensors/Transducers

**System Checklist**

Boiler(s)  
Air Handling Units  
Pumps

**1.4 DEMONSTRATION AND OPERATING AND MAINTENANCE INSTRUCTION**

- .1 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .2 HVAC contractor to schedule and coordinate the demonstration all on the same day, starting at a pre-approved time and continuing consequently until complete.
- .3 Where specified elsewhere in HVAC Division, qualified manufacturers' representatives who are knowledgeable about the project to provide demonstrations and instructions.
- .4 Use operation and maintenance manual, as-built drawings, audio visual aids, etc. as part of instruction materials.
- .5 Instruction duration time requirements as specified in appropriate sections.
- .6 Where deemed necessary, Consultants may record these demonstrations on video tape for future reference.

**1.5 TRIAL USAGE**

- .1 Consultant or owner may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Trial usage to apply to following equipment and systems:
  - .1 HVAC
  - .2 Exhaust air
  - .3 Hydronic water systems
  - .4 Boilers and pumps

- .5 Control systems

## **1.6 DEFICIENCIES**

- .1 During the course of construction, the consultants will monitor construction and provide written reports of work progress, discussions, and instruction to correct work.
- .2 Instruction to correct work shall be done within the work period before the next review.
- .3 The contractor shall not conceal any work until inspected.
- .4 The contractor shall expedite 100% complete rough-in work and have inspected prior to concealing services and equipment especially above ceiling.
- .5 Upon completion of the project the consultant will do a final review. Upon receiving the final inspection report, the contractor must correct and sign back the inspection report indicating the deficiencies are completed. A re-inspection will only be done once consultant receives this in writing.

## **1.7 EQUIPMENT INSTALLATIONS**

- .1 Unions or flanges: provide for ease of maintenance and disassembly.
- .2 Space for servicing, disassembly and removal of equipment and components: provide as recommended by manufacturer or as indicated.
- .3 Equipment drains: pipe to floor drains.
- .4 Install equipment, rectangular cleanouts and similar items parallel to or perpendicular to building lines.

## **1.8 ANCHOR BOLTS AND TEMPLATES**

- .1 Supply anchor bolts and templates for installation by other divisions.

## **1.9 PROTECTION OF OPENINGS**

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

## **1.10 ELECTRICAL**

- .1 Electrical work to conform to Electrical Division including the following:
  - .1 Supplier and installer responsibility and related HVAC responsibility is indicated in Equipment Schedule on HVAC and/or electrical drawings
  - .2 Power wiring and conduit is specified in Electrical Division except for conduit, wiring and connections below 50 V which are related to control systems specified in HVAC Division. Follow Electrical Division for quality of materials and workmanship.
  - .3 Electrically operated equipment shall be C.S.A. approved label. Special Inspection Label of Provincial Authority having jurisdiction will be accepted in lieu of C.S.A. approval. Each motor shall have an approved starter. Starter will be supplied and installed by Electrical Division unless otherwise indicated.

**.4 All starters for HVAC equipment to be provided by this contractor. Wired by Electrical Division.**

**1.11 CONTROL WIRING**

- .1 Furnish and install all components, devices, and control wiring for all HVAC equipment, HVAC systems, lighting, and other electrical loads to make all equipment operable to satisfaction of owner and consultant and to manufacturer's requirements and recommendations.
- .2 All electrical wiring, HVAC wiring and installations shall comply with local and national electrical and HVAC codes.
- .3 Supply and install wiring as required for all devices and systems. Install wiring in EMT conduit and otherwise comply with all requirements of the Electrical Division. Approved plenum wire may be used for sensor and network communication wiring where it complies with appropriate building codes and regulatory authorities.
- .4 All wiring concealed in walls and chases, and all exposed wiring shall be run in conduit.
- .5 Provide recessed conduit and backer boxes where controls are wall mounted. Surface mounted boxes and conduit are acceptable in service rooms.
- .6 Free-run plenum rated cable shall be run in cable hangers where provided by electrical division or tied neatly to pipe and duct hangers in the ceiling. Avoid wiring that droops. Follow building lines and do not run wiring "as the crow flies".

**1.12 MOTORS**

- .1 Provide high efficiency motors for HVAC equipment as specified.
- .2 If delivery of specified motor will delay delivery or installation of any equipment, install motor approved by Consultant for temporary use. Final acceptance of equipment will not occur until specified motor is installed.
- .3 Motors under 373 W, (1/2 hp): speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, voltage as indicated.
- .4 Motors 373 W, (1/2 hp) and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40°C (72°F), 3 phase, voltage as indicated.

**1.13 BELT DRIVES**

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise specified.
- .3 For motors under 7.5 kW 10 hp: standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- .4 For motors 7.5 kW 10 hp and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.

- .5 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .6 Motor slide rail adjustment plates to allow for centre line adjustment.
- .7 Provide sheave changes as required for final air balancing.

#### **1.14 GUARDS**

- .1 Provide guards for unprotected devices.
- .2 Guards for belt drives:
  - .1 Expanded metal screen welded to steel frame.
  - .2 Minimum 1.2 mm (18 gauge) thick sheet metal tops and bottoms.
  - .3 40 mm (1 1/2") diameter holes on both shaft centres for insertion of tachometer.
  - .4 Removable for servicing.
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Install belt guards to allow movement of motors for adjusting belt tension.
- .5 Guard for flexible coupling:
  - .1 "U" shaped, minimum 1.6 mm (16 gauge) thick galvanized mild steel.
  - .2 Securely fasten in place.
  - .3 Removable for servicing.
- .6 Unprotected fan inlets or outlets:
  - .1 Wire or expanded metal screen, galvanized, 20 mm (3/4") mesh.
  - .2 Net free area of guard: not less than 80% of fan openings.
  - .3 Securely fasten in place.
  - .4 Removable for servicing.
- .7 Duct Openings
  - .1 Provide reinforced expanded mesh grating, style 3 (3 lbs/sq.ft.) cover on accessible unprotected duct openings over 300 mm (12") wide and as indicated. This includes all ductwork terminating in air handling units and plenums.
  - .2 Securely Fasten in place.
  - .3 Removable for servicing.

#### **1.15 PIPING AND EQUIPMENT SUPPORTS**

- .1 Equipment supports supplied by equipment manufacturer: specified elsewhere in HVAC Division.
- .2 Piping and equipment supports not supplied by equipment manufacturer: fabricate from structural grade steel meeting requirements of - Structural Steel Section. Submit structural calculations with shop drawings.

- .3 Mount base mounted equipment on chamfered edge housekeeping pads, minimum of 100 mm (4") high and 150 mm (6") larger than equipment dimensions all around. Concrete specified elsewhere.
- .4 Where housekeeping pads incorporate existing pads provide 10 mm dowels into existing pads. New pad height shall match existing.

#### **1.16 SLEEVES**

- .1 Pipe sleeves: at points where pipes pass through masonry, concrete or fire rated assemblies and as indicated. Grout sleeves in place.
- .2 Schedule 40 steel pipe.
- .3 Sleeves with annular fin continuously welded at midpoint:
  - .1 Through foundation walls.
  - .2 Where sleeve extends above finished floor.
  - .3 Through fire rated walls and floors.
- .4 Sizes: minimum 6 mm (1/4") clearance all around, between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Terminate sleeves flush with surface of concrete and masonry walls, concrete floors on grade and 25 mm (1") above other floors.
- .6 Fill voids around pipes:
  - .1 Caulk between sleeve and pipe in foundation walls and below grade floors with waterproof fire retardant non-hardening mastic.
  - .2 Where sleeves pass through walls or floors, provide space for firestopping. Where pipes/ducts pass through fire rated walls, floors and partitions, maintain fire rating integrity.
  - .3 Ensure no contact between copper tube or pipe and ferrous sleeve.
  - .4 Fill future-use sleeves with lime plaster or other easily removable filler.
  - .5 Coat exposed exterior surfaces of ferrous sleeves with heavy application of zinc rich paint to CGSB 1-GP-181M+Amdt-Mar-78.
- .7 Provide minimum 20 gauge duct sleeves where ducts pass through masonry concrete or fire rated assemblies. Maintain minimum 25 mm clearance all around or to the requirements of the authority having jurisdiction. Seal at wall as indicated.

#### **1.17 FIRE STOPPING**

- .1 This contractor shall work with all other contractors on the project in providing one common method of fire stopping all penetrations made in fire rated assemblies.
- .2 Approved fire stopping and smoke seal material in all fire separations and fire ratings within annular space between pipes, ducts, insulation and adjacent fire separation and/or fire rating.
- .3 Do not use cementitious or rigid seals around penetrations for pipe or ductwork where penetrating through walls, floors, ceilings, etc.

- 
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barrier at fire separation.
  - .5 Provide materials and systems capable of maintaining effective barrier against flame, smoke and gases. Ensure continuity and integrity of fire separation.
  - .6 Comply with the requirements of CAN4-S115-M35, and do not exceed opening sized for which they have been tested.
  - .7 Systems to have an F or FT rating (as applicable) not less than the fire protection rating required for closures in a fire separation. Provide “fire wrap” blanket around services penetrating fire walls. Extent of blanket must correspond to ULC recommendations.
  - .8 The fire stopping materials are not to shrink, slump or sag and to be free of asbestos, halogens and volatile solvents.
  - .9 Firestopping materials are to consist of a component sealant applied with a conventional caulking gun and trowel.
  - .10 Fire stop materials are to be capable of receiving finish materials in those areas which are exposed and scheduled to receive finishes. Exposed surfaces are to be acceptable to consultant prior to application of finish.
  - .11 Firestopping shall be inspected and approved by local authority prior to concealment or enclosure.
  - .12 Install material and components in accordance with ULC certification, manufacturers instructions and local authority.
  - .13 Submit product literature and installation material on fire stopping in shop drawing and product data manual. Maintain copies of these on site for viewing by installers and consultant.
  - .14 Manufacturer of product shall provide certification of installation. Submit letter to the consultant.
  - .15 Acceptable Alternate Manufacturers to approval of local authority:
    - .1 Minnesota Mining and Manufacturing
    - .2 Fyresleeve Industries Inc.
    - .3 General Electric Pensil Firestop Systems
    - .4 International Protective Coatings Corp.
    - .5 Rectorseal Corporation (Metacaulk)
    - .6 Proset Systems
    - .7 3M
    - .8 AD Systems
    - .9 Hilti
  - .16 Ensure firestop manufacturer representative performs onsite inspections and certifies installation. Submit inspection reports/certification at time of substantial completion.

---

**1.18 ESCUTCHEONS**

- .1 On pipes and ductwork passing through walls, partitions, floors and ceilings in exposed finished areas and on water and drain pipes inside millwork and cabinets.
- .2 Chrome or nickel plated brass or Type 302 stainless steel, one piece type with set screws.
- .3 Outside diameter to cover opening or sleeve.
- .4 Inside diameter to fit around finished pipe.

**1.19 PAINTING**

- .1 Refer to Section Interior Painting and specified elsewhere.
- .2 Apply at least one coat of corrosion resistant primer paint to ferrous supports and site fabricated work.
- .3 Apply two coats of paint to exposed piping service in service room, base colour as specified in HVAC Identification Section.
- .4 Prime and touch up marred finished paintwork to match original.
- .5 Restore to new condition, or replace equipment at discretion of consultant, finishes which have been damaged too extensively to be merely primed and touched up.

**1.20 SPARE PARTS**

- .1 Furnish spare parts in accordance with general requirements and as follows:
  - .1 One set of packing seals for each pump.
  - .2 One casing joint gasket for each size pump.
  - .3 One head gasket set for each heat exchanger.
  - .4 One set of belts for each type or each size of machinery.
  - .5 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
- .2 Provide list of equipment in maintenance manuals indicating corresponding spare parts required. List of spare parts to be signed off by receiving personnel.

**1.21 SPECIAL TOOLS**

- .1 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Maintenance Materials Special Tools and Spare Parts.

**1.22 ACCESS DOORS**

- .1 Provide access doors to concealed HVAC equipment for operating, inspecting, adjusting and servicing.
- .2 Flush mounted 600 x 600 mm (24" x 24") for body entry and 300 x 300 mm (12" x 12") for hand entry unless otherwise noted. Doors to open 180°, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps.

- .3 Material:
  - .1 Special areas such as tiled or marble surfaces: use stainless steel with brushed satin or polished finish as directed by Consultant.
  - .2 Remaining areas: use prime coated steel.
  - .3 Fire rated areas: provide ULC listed access doors.
  - .4 Washrooms or high moisture area ceilings: Aluminum with mill finish suitable for painting.
- .4 Installation:
  - .1 Locate so that concealed items are accessible.
  - .2 Locate so that hand or body entry (as applicable) is achieved.
- .5 Acceptable materials:
  - .1 Le Hage
  - .2 Zurn
  - .3 Acudor
  - .4 Nailor Industries Inc.

#### **1.23 DIELECTRIC COUPLINGS**

- .1 General:
  - .1 To be compatible with and to suit pressure rating of piping system.
  - .2 Where pipes of dissimilar metals are joined.
- .2 Pipes NPS 50 mm (2") and under: isolating unions.
- .3 Pipes NPS 65 mm (2 1/2") and over: isolating flanges.

#### **1.24 DRAIN VALVES**

- .1 Locate at low points and at section isolating valves unless otherwise specified.
- .2 Minimum NPS 20 mm (3/4") unless otherwise specified: bronze, with hose end male thread and complete with cap and chain.
- .3 Drain valves on potable water systems shall be complete with vacuum breaker.

#### **1.25 REPAIRS, CUTTING, AND RESTORATION**

- .1 Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
- .2 Each Section of this Division shall bear expense of cutting, patching, and repairing to install their work and/or replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.
- .3 Cutting, patching, repairing, and replacing pavements, sidewalks, roads, and curbs to permit installation of work of this Division is responsibility of Section installing work.



- .4 All patching, painting and making good of the existing walls, floors, ceilings, partitions and roof will be at the expense of this Contractor, but performed by the Contractor specializing in the type of work involved unless otherwise noted.

#### **1.26 EXISTING SYSTEMS**

- .1 Connections into existing systems to be made at time approved by Consultant. Request written approval of time when connections can be made.
- .2 Be responsible for damage to existing plant by this work.

#### **1.27 CLEANING**

- .1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units prior to turn over to owner.
- .2 In preparation for final acceptance, clean and refurbish all equipment and leave in operating condition including replacement of all filters in all air and piping systems.

#### **1.28 DISCONNECTION AND REMOVAL**

- .1 Disconnect and/or remove equipment, piping, ductwork, etc. as indicated.
- .2 Cap and conceal all redundant and obsolete connections.
- .3 Provide a list of equipment to be removed to the owner, for his acceptance of same. Remove all equipment from site, which the owner does not retain.
- .4 Store equipment to be retained by owner on site where directed by consultant.

#### **1.29 OWNER SUPPLIED EQUIPMENT**

- .1 Connect to equipment supplied by the owner and make operable.

#### **1.30 DEMOLITION**

- .1 **The general requirements are indicated on the drawings and on the outline specification in Division 1.**
- .2 **The general execution of the demolition is to be carried out in a clean and efficient manner.**
- .3 **Demolition of existing ceiling, walls etc., to facilitate removal of existing services or equipment or installation of new to be kept to a minimum and then restored to match existing.**
- .4 All openings or holes created by removal of existing HVAC systems which are not being reused are to be patched with the same material surrounding surfaces.
- .5 All new holes and openings to facilitate HVAC systems are to be patched to match surrounding surfaces.
- .6 Protect all existing furnishings materials and equipment. Any damage occurring as a result of the work of this Division shall be repaired or replaced at the expense of this Division.

- .7 Where work involves breaking into or connecting to existing services, carry out work at times directed by the Owners in an expedient manner with minimum disruption to the facility and systems downtime.
- .8 Where unknown services are encountered, immediately advise Consultant and confirm findings in writing.
- .9 Where the location of any services has been shown on the plans, such information is not guaranteed. It is this Division's responsibility to verify locations, invert elevations, etc., immediately after moving on site. Should for any reason the information obtained necessitates changes in procedure or design, advise the Consultant at once. If verification of existing conditions is not done at the outset and any problems arise, the responsibility for same is entirely this Division's.

**1.31 EXISTING CONCRETE SLAB X-RAY/SCANNING**

- .1 This contractor shall retain the services of a qualified company to provide and X-ray and/or scan of the existing buried services in wall and/or floors prior to starting any work in the affected area.
- .2 Failure to locate existing piping, conduit rebar etc., shall not relieve this contractor of repair of same prior to installing his service.
- .3 This contractor shall be responsible for all repairs and/or replacement of existing services caused by cutting the existing concrete slabs and/or walls.

**1.32 EXCAVATING AND BACKFILLING**

- .1 Provide all excavating and backfilling inside and outside the building for any buried services. All backfilling shall be new clean granular 'A' fill brought in specifically for the purpose of backfilling to the underside of floor slab. All backfilling shall be compacted at intervals not more than 150 mm (6") layer to the satisfaction of the Consultant.
- .2 Provide excavating and backfilling outside the building with granular A brought in specifically for backfilling to a minimum of 450 mm (18") over the pipe or ductwork. Backfilling outside building over and above the 450 mm (18") backfill as previously specified herein shall be by the HVAC Contractor as specified under Division 2. Where backfilling outside the building is not specified under Division 2 the HVAC contractor shall provide new clean granular 'A' fill to grade level.
- .3 Bottoms of trenches shall be excavated so that the pipe will be supported on a 150 mm (6") compacted bed of clean granular 'A' fill. Provide all necessary pumping to maintain excavation free of water.
- .4 Should water be encountered during excavation, the HVAC contractor shall provide all labour and material, including all equipment required for dewatering the excavation. After the water has been removed, this Contractor shall install a 300 mm (12") base of compacted 50 mm (2") clear stone covered with filter cloth before installing backfill as detailed and/or as specified.
- .5 Be responsible for all weather protection required to install piping and/or equipment to the satisfaction of the Consultant.

- .6 Be responsible for providing all clear stone or granular 'A' material suitable for application to replace existing soil not suitable for backfilling above the 450 mm (18") bedding material.

#### **1.33 CONFINED SPACES**

- .1 Certain areas of the building may be defined as a "Confined Space". Any personnel working in these areas must have confined space training, appropriate equipment and undertake all work in conformance with appropriate codes and standards.
- .2 Refer to building documentation for any spaces deemed "Confined Space".

#### **1.34 TSSA INSPECTION**

- .1 Prior to final completion of the project, this contractor shall make application, arrange, and pay for a TSSA inspection of all piping systems and equipment installations, including, but not limited to medical gasses, refrigeration, fuel piping, compressed air, heating plant, cooling plant, and associated equipment installed under the contract.
- .2 Provide a copy of the TSSA report in the maintenance manuals for each system.

#### **1.35 INTEGRATED LIFE SAFETY SYSTEMS TESTING**

- .1 HVAC systems in this building, including but not limited to smoke control dampers, smoke control fans, high speed low velocity ceiling fans, makeup air units, and heat tracing for fire protection systems may be subject to Integrated Life Safety Systems testing.
- .2 The HVAC Contractor shall co-ordinate with the Integrated Life Safety Systems Testing Agent as follows:
  - .1 Confirm which HVAC systems are to be included as part of the testing process.
  - .2 Verify in writing to the Integrated Life Safety Systems Testing Agent that HVAC commissioning of the affected systems/devices is complete prior to the scheduled testing date(s).
  - .3 Participate in the Integrated Life Safety Systems Testing to confirm proper operation of all associated systems.
  - .4 This contractor shall work with the Integrated Life Safety Systems Testing Agent to reset all systems back to normal operating mode after the testing is complete.
- .3 Include all costs associated with Integrated Life Safety System Testing in the tender value.
- .4 Refer to Division 1/Division 26 Integrated Life Safety Systems Testing specifications for additional information/requirements.

#### **1.36 REFRIGERANT CONTAINING EQUIPMENT**

- .1 A2L refrigerants are classified as mildly flammable. CSA B52-2023 has specific safety clauses related to the use of refrigerants with this classification within buildings.
- .2 This Contractor shall be responsible to ensure that the installation requirements of CSA B52-2023 are met.

- .3 Throughout this specification various pieces of equipment have been specified with refrigerant leak detection systems. Field wiring of the alarm status of this system to various downstream system components is required under Annex P of the standard and is the responsibility of this Contractor. These devices include the following:
  - .1 Open all zone dampers connected to the affected system.
  - .2 Disable electric reheat coils within the affected system.
  - .3 Activate field installed safety shut off valves on the affected refrigeration systems
  - .4 De energize any potential sources of ignition with the ductwork system of the affected system.
  - .5 Energize fans within the ductwork system.
  - .6 Activate any designated refrigeration leak ventilation systems.

**1.37 FREEZE PROTECTION**

- .1 Do not run lines in outside walls, or locations where freezing may occur. Piping next to outside walls shall be in furred spaces with insulation between the piping and the outside wall. Insulation of piping shall not be considered freeze protection.

**1.38 SCAFFOLDING, RIGGING, AND HOISTING**

- .1 Provide all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished; remove same from premises when no longer required. Conform to OSHA requirements and standards.

**1.39 COOPERATION WITH OTHER TRADES**

- .1 Give full cooperation to other trades and furnish in writing to other trades, with copies to the engineer, any information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay.
- .2 Where plumbing work will be installed in close proximity to, or will interfere with work of other trades, assist in working out space conditions to make a satisfactory adjustment. Prepare composite working drawings and sections at a suitable scale, not less than ¼ inches = 1-foot – 0-inches, clearly showing how the HVAC work is to be installed in relation to the work of other trades. If work is installed before coordinating with other trades, or if it causes any interference with work of other trades, make the necessary changes in the work to correct the conditions and bear all costs.
- .3 Furnish to other trades necessary templates, patterns, setting drawings, and shop details for the proper installation of work and for coordinating adjacent work.

**1.40 WATERPROOFING SEAL MATERIALS**

- .1 Modular, compressed seal assemblies consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and pipe sleeve or wall opening, assembled with stainless steel bolts and pressure plates and designed so when bolts are tightened the links expand to seal the opening watertight. Select seal assemblies to suit pipe size and sleeve size or wall opening size.

- .2 Standard of quality assurance manufacturers are:
  - .1 Thunderline Corp. (Power Plant Supply Co.) “Link Seal” Model S-316
  - .2 The Metraflex Co. “MetraSeal” type ES
  - .3 Or approved equivalent.

**1.41 SLEEVE, CUT, AND FORMED OPENING LOCATION DRAWINGS**

- .1 Prepare and submit for review, drawings indicating size and location of required sleeves, recesses, and formed openings in poured or precast concrete work.
- .2 Such drawings are to be completely and accurately dimensioned and relate sleeve, recesses, and formed openings to suitable grid lines and elevation datum, and are to take into account structural items such as grade beams, column caps, and column drop slabs.
- .3 Begin to prepare such drawings immediately upon notification of acceptance of bid and award of Contract.

**1.42 SUSTAINABLE CONSTRUCTION**

- .1 Construction Waste Management:
  - .1 Recycle all waste materials to avoid land fill sites where possible.
  - .2 All metal contents shall be recycled.
  - .3 All cardboard and paper shall be recycled.
  - .4 All plastic packaging shall be recycled.
  - .5 All wood shall be directed to the appropriate recycled wood section at the landfill site.
- .2 This contractor is responsible for their own waste management system and cost associated with the disposal. This can be their own on site system, daily removal, back to shop, or a communal system shared with other contractors on site.
- .3 In all cases the cost to remove materials on site are the cost of this contractor.

**END OF SECTION**

**Part 1            General**

**1.1                GENERAL PROVISIONS**

- .1        Conform to the General Provisions of General Requirements Section.
- .2        This project is one of a retrofit nature in part, and which will require some demolition.
- .3        Allow for all remedial work in areas indicated on the drawings and as generally defined in the relevant sections of the specifications.

**1.2                RELATED WORK SPECIFIED ELSEWHERE**

- .1        Electrical Division.

**1.3                SCOPE OF WORK**

- .1        The scope of work is essentially the selected disconnection and/or removal of services and/or equipment, piping ductwork etc. as indicated or required to complete the work.

**Part 2            Products**

**2.1                GENERAL**

- .1        This Division is to liaise with the Owners or Consultant for equipment being removed that may be suitable for reuse to that specified or handed over to the owner.
- .2        This Division to take full responsibility for any special tools or equipment required to disassemble or remove material from building.

**Part 3            Execution**

**3.1                GENERAL**

- .1        The general requirements are indicated on the drawings and on the outline specification in Division 1.
- .2        The general execution of the demolition is to be carried out in a clean and efficient manner.
- .3        Demolition of existing ceiling, walls etc., to facilitate removal of existing services or equipment or installation of new to be kept to a minimum and then restored to match existing.
- .4        All openings or holes created by removal of existing HVAC systems which are not being reused are to be patched with the same material surrounding surfaces.
- .5        All new holes and openings to facilitate HVAC systems are to be patched to match surrounding surfaces.

- .6 Protect all existing furnishings materials and equipment. Any damage occurring as a result of the work of this Division shall be repaired or replaced at the expense of this Division.
- .7 Where work involves breaking into or connecting to existing services, carry out work at times directed by the Owners in an expedient manner with minimum disruption to the facility and systems downtime.
- .8 Where unknown services are encountered, immediately advise Consultant and confirm findings in writing.
- .9 Where the location of any services has been shown on the plans, such information is not guaranteed. It is this Division's responsibility to verify locations, invert elevations, etc., immediately after moving on site. Should for any reason the information obtained necessitates changes in procedure or design, advise the Consultant at once. If verification of existing conditions is not done at the outset and any problems arise, the responsibility for same is entirely this Division's.
- .10 Disconnect and/or remove equipment piping, ductwork, etc. as indicated.
- .11 Cap and conceal all redundant and obsolete connections.
- .12 Provide a list of equipment to be removed to the owner, for his acceptance of same. Remove all equipment from site which the owner does not retain.
- .13 Maintain equipment to be retained by owner on site where directed by consultant.
- .14 Demolition of all parts of the work must be completed within the confines of the work area and in such a way as the dust produced and risk to injury of will not adversely affect the building users.
- .15 Demolished areas of the existing building will remain in their current use in some cases. Demolition in these areas must be kept to the minimum required to complete the work.
- .16 Demolition shall take place within areas isolated from all other areas with appropriate hoarding, scaffolding, netting, fencing or other means of security between building users and the work.
- .17 Co-ordinate making safe electrical devices, capping plumbing and removal of fixtures prior to commencement of demolition.
- .18 All piping and equipment to be removed and/or abandoned shall be drained prior to capping and/or abandoning. Disposal of all liquids shall be to the approval of authority of having jurisdiction and/or provincial regulations.

### **3.2 EXISTING SYSTEM DRAINAGE**

- .1 Drain all existing piping systems including all related equipment as required to facilitate system renovations.
- .2 Disposal of existing system shall be to the requirements of the local and/or provincial regulations.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 American Society for Testing and Materials
  - .1 ASTM A53/A53M, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
  - .2 ASTM A105/A105M, Specification for Carbon Steel Forgings for Piping Applications.

**1.2            PRODUCT DATA**

- .1 Submit product data in accordance with general requirements.
- .2 Indicate for each item as applicable:
  - .1 Manufacturer, model number, line contents, pressure and temperature rating.
  - .2 Movement handled; axial, lateral, angular and the amounts of each.
  - .3 Nominal size and dimensions including details of construction and assembly.

**1.3            CLOSEOUT SUBMITTALS**

- .1 Submit maintenance data in accordance with general requirements.
- .2 Data to include:
  - .1 Servicing requirements, including any special requirements, stuffing box packing, lubrication and recommended procedures.

**Part 2            Products**

**2.1            SLIP TYPE EXPANSION JOINTS**

- .1 Application: for axial pipe movement, as indicated.
- .2 Repacking: under full line pressure.
- .3 Body and packing housings: Class 150, 1Mpa carbon steel pipe to ASTM A53/A53M, Grade B. Wall thickness to match pipe and with raised face slip-on flanges to match pipe.
- .4 Slip or traverse sleeves: carbon steel pipe to ASTM A53/A53M, Grade B, hard chrome plated.
- .5 Anchor base: construction steel, welded to body.
- .6 Guides (internal and external): embody into packing housing with concentric alignment of slip or traverse sleeve with packing housing.
- .7 Extension limit stop: stainless steel, to prevent over-extension with accessible and removable pins.



- .8 Packing rings: 6 minimum, P7FE (teflon) or graphite impregnated non-asbestos fiber.
- .9 Thermal plastic packing: P7FE (teflon) or graphite impregnated non-asbestos fiber slug supplied loose.
- .10 Lubricating fittings: pet cocks with grease nipple.
- .11 Plunger body and plunger:
  - .1 Plunger body: heavy wall carbon steel welded to body.
  - .2 Plunger: carbon steel with hex head for use with socket wrench.
- .12 Lubricant: to manufacturer's recommendations.
- .13 Lubricant gun: complete with hose assembly.
- .14 Drip connection: 20 MPa (2900 psi) forged steel to ASTM A105. Include half coupling with drain plug.
- .15 Lubricant fittings, plunger, gun not required for low friction self lubricating packing.

## **2.2 BELLOWS TYPE EXPANSION JOINTS**

- .1 For axial, lateral or angular movements, as indicated.
- .2 Maximum operating pressure: 1034 kPa (150 psi).
- .3 Maximum operating temperature: 200°C (392°F).
- .4 Type A: free flexing, factory tested to 1½ times maximum working pressure. Furnish test certificates.
- .5 Type B: externally pressurized, constant volume, pressure balanced, designed to eliminate pressure thrust, factory tested to 1.5 times maximum working pressure. Furnish test certificates.
- .6 Bellows:
  - .1 Multiple bellows, hydraulically formed, two ply, austenitic stainless steel for specified fluid, pressure and temperature, water treatment and pipeline cleaning procedures.
- .7 Reinforcing or control rings:
  - .1 2 piece nickel iron.
- .8 Ends:
  - .1 Slip-on flanges to match pipe.
- .9 Liner:
  - .1 Austenitic stainless steel in direction of flow.
- .10 Shroud:
  - .1 Carbon steel, painted.

## **2.3 FLEXIBLE CONNECTION**

- .1 Application: to suit motion.

- .2 Minimum length in accordance with manufacturer's recommendations to suit offset.
- .3 Inner hose: stainless steel corrugated.
- .4 Braided wire mesh stainless steel outer jacket.
- .5 Diameter and type of end connection: as indicated.
- .6 Operating conditions:
  - .1 Working pressure: 1034 kPa (150 psi).
  - .2 Working temperature: 250°C (482°F).
  - .3 To match system requirements.

## **2.4 ANCHORS AND GUIDES**

- .1 Anchors:
  - .1 Provide as indicated.
- .2 Alignment guides:
  - .1 Provide as indicated.
  - .2 To accommodate specified thickness of insulation.
  - .3 Vapour barriers, jackets to remain uninterrupted.

## **2.5 EXPANSION COMPENSATORS (EXP)(2"-4")**

- .1 All welded packless guided construction complete with multi ply stainless steel bellows.
- .2 Operating temperature (700°F).
- .3 Provide model HP3 for steel pipe and model HBFF3 for copper pipe.
- .4 Movement capability of 4" axial. Welded ends.
- .5 Material to match piping system.
- .6 Acceptable materials:
  - .1 Metraflex HP
  - .2 Mark David Canada
  - .3 Senior Flexonics

## **2.6 EXPANSION COMPENSATORS (6"-16")**

- .1 All welded packless guided construction complete with multi ply stainless steel bellows.
- .2 Operating temperature (700°F).
- .3 Movement capability of 4" axial. Welded ends.
- .4 Material to match piping system.
- .5 Acceptable materials:
  - .1 Metraflex Metragator
  - .2 Mark David Canada
  - .3 Senior Flexonics

---

**2.7 VRF EXPANSION LOOPS**

- .1 Flexible hose expansion loop as required by VRF manufacturer.
- .2 Operating pressure: 700 psi.
- .3 Operating temperature: 300° Fahrenheit.
- .4 Corrugated Type 321 stainless steel with braid of double layer Type 304 stainless steel.
- .5 Schedule 40 Type 304 stainless steel fittings complete with stainless to copper conversion fittings where required.
- .6 Complete with hanger/support lug at bottom of 180° return.
- .7 Acceptable materials:
  - .1 Metraflex Metraloop
  - .2 Senior Flexonics

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install expansion joints with cold setting, as indicated as instructed by Consultant. Make record of cold settings.
- .2 Install expansion joints and flexible connections in accordance with manufacturer's instructions.
- .3 Install pipe anchors and guides as indicated. Anchors to withstand 150% of axial thrust.

**3.2 APPLICATION**

- .1 Provide on all vibration isolated equipment.
- .2 Provide where requested by equipment manufacturers installation manuals.
- .3 Install in accordance with manufacturer's recommendations.
- .4 **Provide expansion compensators (exp.) on radiation heating element exceeding 3.6 M (12' – 0") in length. Provide one expansion compensators on each length of return piping in cabinet.**

**3.3 THERMAL EXPANSION**

- .1 Provide in long runs of heating mains exceeding 100 ft. in length.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1    All codes, standards, etc. as referenced shall be the latest edition.
- .2    ANSI/ASME B40.100, Pressure Gauges and Gauge Attachments.
- .3    CAN/CGSB-14.4, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.
- .4    CAN/CGSB-14.5, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.

**1.2            SHOP DRAWINGS AND PRODUCT DATA**

- .1    Submit shop drawings and product data in accordance with general requirements.
- .2    Submit manufacturer's product data for following items:
  - .1    Thermometers.
  - .2    Pressure gauges.
  - .3    Stop cocks.
  - .4    Syphons.
  - .5    Wells.

**Part 2            Products**

**2.1            GENERAL**

- .1    Design point to be at mid point of scale or range.
- .2    Ranges: suitable for application.

**2.2            DIRECT READING THERMOMETERS**

- .1    Industrial, variable angle type, liquid filled, 225 mm (9") scale length: to CAN/CGSB 14.4.
  - .1    Acceptable materials:
    - .1    Trerice
    - .2    Winters 91T
    - .3    Wiess

**2.3            REMOTE READING THERMOMETERS**

- .1    100 mm (4") diameter liquid filled activated dial type: to CAN/CGSB-14.5, accuracy within one scale division, brass movement, stainless steel capillary, stainless steel spiral armour, stainless steel bulb and polished stainless steel case for wall mounting.
  - .1    Acceptable materials:
    - .1    Trerice
    - .2    Winters Contractor

## **2.4 THERMOMETER WELLS**

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

## **2.5 PRESSURE GAUGES**

- .1 115 mm (4 1/2"), dial type: to ANSI/ASME B40.100, Grade 2A, stainless steel phosphor bronze bourdon tube having 0.5% accuracy full scale unless otherwise specified.
  - .1 Acceptable materials:
    - .1 Winters
    - .2 Trerice
    - .3 Wiess
  - .2 Provide:
    - .1 Siphon for steam service.
    - .2 Snubber for pulsating operation.
    - .3 Diaphragm assembly for corrosive service.
    - .4 Gasketed pressure relief back with solid front.
    - .5 Bronze stop cock.

## **Part 3 Execution**

### **3.1 GENERAL**

- .1 Install so they can be easily read from floor or platform. If this cannot be accomplished, install remote reading units.
- .2 Install between equipment and first fitting or valve.

### **3.2 THERMOMETERS**

- .1 Install in wells on all piping. Provide heat conductive material inside well.
- .2 Install in locations as indicated and on inlet and outlet of:
  - .1 Heat exchangers.
  - .2 Water heating and cooling coils.
  - .3 Water Boilers
  - .4 Boiler Room HWS and HWR.
  - .5 In other locations indicated.
- .3 Install wells as indicated only for balancing purposes.
- .4 Use extensions where thermometers are installed through insulation.

### **3.3 PRESSURE GAUGES**

- .1 Install in following locations:
  - .1 Suction and discharge of pumps.
  - .2 Upstream and downstream of PRV's.
  - .3 Upstream and downstream of control valves.
  - .4 Inlet and outlet of coils.
  - .5 Inlet and outlet of liquid side of heat exchangers.
  - .6 Outlet of boilers.
  - .7 In other locations as indicated.
- .2 Install gauge cocks for balancing purposes, elsewhere as indicated.
- .3 Use extensions where pressure gauges are installed through insulation.

### **3.4 NAMEPLATES**

- .1 Install engraved lamicoid nameplates as specified elsewhere identifying medium.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 American National Standards Institute/ American Society of Mechanical Engineers (ANSI/ASME)
  - .1 ANSI/ASME B31.1, Power Piping, (SI Edition).
- .3 American Society for Testing and Materials (ASTM)
  - .1 ASTM A 125, Specification for Steel Springs, Helical, Heat-Treated.
  - .2 ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .3 ASTM A 563, Specification for Carbon and Alloy Steel Nuts.
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
  - .1 MSS SP-58, Pipe Hangers and Supports - Materials, Design, Manufacture Selection, Application, and Installation.

**1.2            DESIGN REQUIREMENTS**

- .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
- .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP-58.
- .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.
- .4 Design hangers and supports to support systems under all conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
- .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment to be in accordance with MSS SP-58.

**1.3            SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with general requirements.
- .2 Submit shop drawings and product data for following items:
  - .1 All bases, hangers and supports.
  - .2 Connections to equipment and structure.
  - .3 Structural assemblies.

**1.4            MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.

**Part 2 Products**

**2.1 GENERAL**

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS-SP-58.
- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

**2.2 PIPE HANGERS**

- .1 Finishes:
  - .1 Pipe hangers and supports: to ANSI & ULC requirements
  - .2 Ensure steel hangers in contact with copper piping are copper plated.
- .2 Upper attachment structural: Suspension from upper flange of I-Beam or joist.
  - .1 Cold piping NPS 50 mm (2") maximum: Ductile iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
    - .1 Rod: 10 mm (3/8") UL listed
  - .2 Cold piping NPS 65 mm (2 1/2") or greater, all hot piping: Malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed & FM approved.
- .3 Upper attachment structural: Suspension from upper flange of I-Beam.
  - .1 Cold piping NPS 50 mm (2") maximum: Ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed.
  - .2 Cold piping NPS 65 mm (2 1/2") or greater, all hot piping: Malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nuts.
- .4 Upper attachment to concrete.
  - .1 Ceiling: Carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm (1/4") minimum greater than rod diameter.
  - .2 Concrete inserts: wedge shaped body with knockout protector plate ULC listed. Note: Rapidex and Siporex are not considered concrete. Should one of these systems be encountered, piping/ductwork and/or equipment shall be supported from adjacent walls or from supplemental steel provided by this contractor attached to the adjacent walls/structure.
- .5 Shop and field-fabricated assemblies.
  - .1 Trapeze hanger assemblies: ASME B31.1.
  - .2 Steel brackets: ASME B31.1.
- .6 Hanger rods: threaded rod material to MSS SP-58.
  - .1 Ensure that hanger rods are subject to tensile loading only.
  - .2 Provide linkages where lateral or axial movement of pipework is anticipated.



- 
- .7 Pipe attachments: material to MSS SP-58.
    - .1 Attachments for steel piping: carbon steel.
    - .2 Attachments for copper piping: copper plated black steel.
    - .3 Use insulation shields for all piping.
    - .4 Oversize pipe hangers and supports to accommodate thermal insulation. Provide 1.5 mm (16 gauge) saddles.
  - .8 Adjustable clevis: material to MSS SP-58 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
    - .1 Ensure "U" has hole in bottom for rivetting to insulation shields.
  - .9 **Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP-69.**
  - .10 **U-bolts: carbon steel to MSS SP-58 with 2 nuts at each end to ASTM A 563.**
    - .1 **Finishes for steel pipework: black**
    - .2 **Finishes for copper, glass, brass or aluminum pipework: black with formed portion plastic coated.**
  - .11 **Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP-58.**
- 2.3 RISER CLAMPS**
- .1 Steel or cast iron pipe: black carbon steel to MSS-SP-58, type 42, UL listed.
  - .2 Copper pipe: carbon steel copper plated to MSS-SP-58, type 42.
  - .3 Bolts: to ASTM A 307.
  - .4 Nuts: to ASTM A 563.
- 2.4 INSULATION PROTECTION SHIELDS**
- .1 Insulated cold piping:
    - .1 64 kg/m<sup>2</sup> (13.12 lbs/ft<sup>2</sup>) density insulation plus insulation protection shield to: MSS SP-69, galvanized sheet carbon steel. Length designed for maximum 3 m (10') span.
  - .2 Insulated hot piping:
    - .1 Curved plate 300 mm (12") long, with edges turned up, welded-in centre plate for pipe sizes NPS 300 mm (12") and over, carbon steel to comply with MSS SP-58.
- 2.5 CONSTANT SUPPORT SPRING HANGERS**
- .1 Springs: alloy steel to ASTM A 125, shot peened, magnetic particle inspected, with +/- 5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.
  - .2 Load adjustability: [10]% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.
  - .3 Provide upper and lower factory set travel stops.

- .4 Provide load adjustment scale for field adjustments.
- .5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm (1") minimum.
- .6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

## **2.6 VARIABLE SUPPORT SPRING HANGERS**

- .1 Vertical movement: 15 mm (1/2") minimum, 50 mm (2") maximum, use single spring pre-compressed variable spring hangers.
- .2 Vertical movement greater than 50 mm (2"): use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.
- .3 Variable spring hanger to be complete with factory calibrated travel stops. Provide certificate of calibration for each hanger.
- .4 Steel alloy springs: to ASTM A 125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.

## **2.7 EQUIPMENT SUPPORTS**

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of miscellaneous metals, specified herein. Submit calculations with shop drawings.

## **2.8 EQUIPMENT ANCHOR BOLTS AND TEMPLATES**

- .1 Provide templates to ensure accurate location of anchor bolts.

## **2.9 HOUSE-KEEPING PADS**

- .1 For base-mounted equipment: Reinforced concrete, at least 100 mm (4") high, 150 mm (6") larger all around than equipment, and with chamfered edges as indicated.
- .2 Size of housekeeping pads shall be determined from approved shop drawings.
- .3 Concrete: 30 Mpa concrete with reinforced wire mesh.
- .4 Install all housekeeping pads not indicated on architectural drawings.

## **2.10 OTHER EQUIPMENT SUPPORTS**

- .1 From structural grade steel meeting requirements of structural steel section specified herein.
- .2 Submit structural calculations with shop drawings.

---

**2.11 MANUFACTURER**

- .1 Acceptable materials:
  - .1 Grinnell
  - .2 Anvil
  - .3 Myatt
  - .4 Taylor

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install in accordance with:
  - .1 Manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
  - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, elsewhere as indicated.
- .3 Clamps on riser piping:
  - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
  - .2 Bolt-tightening torques to be to industry standards.
  - .3 Steel pipes: Install below coupling or shear lugs welded to pipe.
  - .4 Cast iron pipes: Install below joint.
- .4 Clevis plates:
  - .1 Attach to concrete with 4 minimum concrete inserts at each corner.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .6 **Use approved constant support type hangers where:**
  - .1 **Vertical movement of pipework is 15 mm (1/2") or more,**
  - .2 **Transfer of load to adjacent hangers or connected equipment is not permitted.**
- .7 **Use variable support spring hangers where:**
  - .1 **Transfer of load to adjacent piping or to connected equipment is not critical.**
  - .2 **Variation in supporting effect does not exceed 25% of total load.**

**3.2 HANGER SPACING**

- .1 Plumbing piping: most stringent requirements of Canadian Plumbing Code, Provincial Code, or authority having jurisdiction.
- .2 Fire protection: to applicable fire code.
- .3 Gas and fuel oil piping: up to NPS 15 mm (1/2"): every 1.8 m (6').

- .4 Copper piping: up to NPS 15 mm (1/2"): every 1.5 m (5').
- .5 **Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.**
- .6 Within 300 mm (12") of each elbow and:

Maximum Pipe Size: NPS	Spacing Steel	Maximum Spacing Copper
up to 32 mm (1 1/4")	2.1 m (7')	1.8 m (6')
40 mm (1 1/2")	2.7 m (9')	2.4 m (8')
50 mm (2")	3.0 m (10')	2.7 m (9')
65 mm (2 1/2")	3.6 m (12')	3.0 m (10')
80 mm (3")	3.6 m (12')	3.0 m (10')
90 mm (3 1/2")	3.9 m (13')	3.3 m (11')
100 mm (4")	4.2 m (14')	3.6 m (12')
125 mm (5")	4.8 m (16')	
150 mm (6")	5.1 m (17')	
200 mm (8")	5.7 m (19')	
250 mm (10")	6.6 m (22')	
300 mm (12")	6.9 m (23')	

- .7 Pipework greater than NPS 300 mm (12"): to MSS SP-69.

### 3.3 HANGER INSTALLATION

- .1 Install hanger so that rod is vertical under operating conditions.
- .2 Adjust hangers to equalize load.
- .3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.
- .4 Do "NOT" support piping, ductwork and equipment from roof deck, on bottom chord of floor and/or roof joist and/or from OWSJ bridging. Provide structural member between joist.

### 3.4 HORIZONTAL MOVEMENT

- .1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4mm (5/32") from vertical.
- .2 Where horizontal pipe movement is less than 15 mm (1/2"), offset pipe hanger and support so that rod hanger is vertical in the hot position.

### 3.5 FINAL ADJUSTMENT

- .1 Adjust hangers and supports:
  - .1 Ensure that rod is vertical under operating conditions.
  - .2 Equalize loads.

- .2 Adjustable clevis:
  - .1 Tighten hanger load nut securely to ensure proper hanger performance.
  - .2 Tighten upper nut after adjustment.
- .3 C-clamps:
  - .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- .4 Beam clamps:
  - .1 Hammer jaw firmly against underside of beam.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 American National Standards Institute/ American Society of Mechanical Engineers (ANSI/ASME)
  - .1 ANSI/ASME B31.1, Power Piping, (SI Edition).
- .3 American Society for Testing and Materials (ASTM)
  - .1 ASTM A 125, Specification for Steel Springs, Helical, Heat-Treated.
  - .2 ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .3 ASTM A 563, Specification for Carbon and Alloy Steel Nuts.
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
  - .1 MSS SP-58, Pipe Hangers and Supports - Materials, Design, Manufacture Selection, Application, and Installation.
- .5 CSA B272-93 – Prefabricated Self-Sealing Roof Vent Flashings
- .6 CRCA (Canadian Roofing Contractor's Association)
- .7 SPRI (Single Ply Roofing Institute)
- .8 CUFCA (Canadian Urethane Foam Contractor's Association) and CGSB-51-GP-46MP, Manual for "Installers of Spray Polyurethane Foam Thermal Insulation"
- .9 CSA G40.21-M1987, M350W, and M300W (Structural Quality Steels)
- .10 CSA W47.1-1983 (Certificate of Companies for Fusion Welding of Structural Steel)
- .11 CSA W59-M1989 (Welded Steel Construction – Metal Arc Welding)
- .12 CSA G164-M1981 (Hot Dip Galvanizing of Irregularly Shaped Articles)

**1.2            RELATED SECTIONS**

- .1 Section 03300 – Cast-in-place Concrete
- .2 Section 05210 – Steel Joists
- .3 Section 05300 – Metal Deck
- .4 Section 06100 – Rough Carpentry
- .5 Section 07200 – Thermal Protection
- .6 Section 07500 – Membrane Roofing
- .7 Section 07900 – Joint Sealers

**1.3            DESIGN REQUIREMENTS**

- .1 Construct support systems to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.

- .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP-58.
- .3 Design supports to support systems under all conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
- .4 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment to be in accordance with MSS SP-58.

#### **1.4 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with general requirements.
- .2 Submit shop drawings and product data for following items:
  - .1 All bases, hangers and supports.
  - .2 Connections to equipment and structure.
  - .3 Structural assemblies.
- .3 Manufacturer's installation instruction.

#### **1.5 MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.

#### **1.6 QUALITY ASSURANCE**

- .1 Roof accessories manufactures to have minimum five (5) years documented experience in the design and fabrication of roofing specialties and accessories.

#### **1.7 SPECIAL WARRANTY**

- .1 Warrant products installed under this section of work to be free of leaks, condensation, and defects in materials and/or manufacture for a period of twenty (20) years when installed in accordance with the manufacturer's written instructions.

### **Part 2 Products**

#### **2.1 PIPE/SUPPORT**

- .1 Pipe/Support:
  - .1 Adjustable height 6061-T6, hollow aluminum with mill finish, urethane insulated supports, 2" (51mm) diameter.
- .2 Stack Jack Flashing:
  - .1 Height to suit application.
  - .2 Fully urethane insulated.
  - .3 Aluminum construction.
  - .4 Complete with EPDM triple pressure grommet seal and EPDM base seal and other accessories as required to suit roof type.

- .3 Provide appropriate stainless steel mounting hardware to suit supported pipe/equipment.
- .4 Provide appropriate system support as specified in this section to suit application.
  - .1 Single Plain Pipe: Type 304 stainless steel pipe roller assembly to suite actual O.D pipe.
  - .2 Double Plain Pipe: Type 304 stainless steel pipe roller assemblies sized to suit actual O.D pipe.
  - .3 Single Insulated Pipe: Type 304 stainless steel pipe cradle assembly sized to suit actual O.D of insulated pipe.
  - .4 Double insulated Pipe: Type 304 stainless steel pipe cradle assemblies sized to suit actual O.D of insulated pipe.
- .5 Basis of design/Acceptable Manufacturer
  - .1 Thaler MERS 600 series.
  - .2 Acceptable equals if submitted during tender period.

## **2.2 DUCT SUPPORT**

- .1 Duct support:
  - .1 Adjustable height 6061-T6, hollow aluminum with mill finish, urethane insulated supports, 2" (51mm) diameter.
- .2 Stack Jack Flashing:
  - .1 Height to suit application.
  - .2 Fully urethane insulated.
  - .3 Aluminum construction.
  - .4 Complete with EPDM triple pressure grommet seal and EPDM base seal and other accessories as required to suit roof type.
- .3 Provide appropriate stainless steel mounting hardware to suit application.
- .4 Cross-bar carrier assembly of length to suit application with EPDM end caps.
- .5 Basis of design/Acceptable Manufacturer
  - .1 Thaler MERS-800 series.
  - .2 Acceptable equals if submitted during tender period.

## **2.3 ROOFED IN EQUIPMENT SUPPORT (SMALL UNITS)**

- .1 Equipment supports:
  - .1 Adjustable height 6061-T6, hollow aluminum with mill finish, urethane insulated supports, 2" (51mm) diameter.
- .2 Stack Jack Flashing:
  - .1 Height to suit application.
  - .2 Fully urethane insulated.
  - .3 Aluminum construction.



- .4 Complete with EPDM triple pressure grommet seal and EPDM base seal and other accessories as required to suit roof type.
- .3 Provide appropriate stainless steel mounting hardware to suit application.
- .4 Cross-bar carrier of length to suit application with EPDM end caps, anti-vibration pads and 1 1/2" (38mm) diameter pipe section reinforcing ties.
- .5 Basis of design/Acceptable Manufacturer:
  - .1 Thaler MERS-900 series.
  - .2 Acceptable equals if submitted during tender period.

## **2.4 EQUIPMENT ANCHOR BOLTS AND TEMPLATES**

- .1 Provide templates to ensure accurate location of anchor bolts.

## **2.5 ROOF CURB MOUNTED EQUIPMENT**

- .1 Install as per manufacturer's instructions on roof curbs provided by manufacturer as indicated.
- .2 Provide all necessary continuous pressure treated wood blocking and 24 gauge metal liner on all exposed wood as required to install roof curb level.

## **2.6 MANUFACTURED ROOF SUPPORTS**

- .1 Single piece injection moulded polypropylene support.
- .2 Type 3-20 psi extruded polystyrene UV protected base glued to the support.
- .3 Minimum base dimension of 300 x 225 (12" x 9") and be 140 mm (5.5") high.
- .4 Pull test of 1.4 KN (315 lbs) using two #14-10 screws on pipe strap.
- .5 Acceptable materials:
  - Quick Block
  - Erico

## **2.7 ALUMINUM ROOF SUPPORTS**

- .1 450 mm high aluminum pipe support.
- .2 Adjustable leg assembly, base plate, roller assembly.
- .3 Acceptable material:
  - Thaler Mers-600A Series.

## **2.8 PIPING THROUGH ROOF**

- .1 Provide Thaler MEF-9 or equal gas piping flashing where pipe and/or relief vent penetrates roof.

## **2.9 ROOF MOUNTED DUCT SUPPORT**

- .1 Provide zero penetration duct support on roof where indicated.
- .2 Base shall be made of high density polypropylene with UV protection.

- .3 Frames shall be galvanized. All fastenings, rods, nuts, washers, etc. shall be stainless steel.
- .4 Provide shop drawings as specified. Install to manufacturers recommendations.
- .5 Acceptable materials:
  - .1 Portable pipe hanger
  - .2 Bigfoot systems
  - .3 Miro rooftop support
  - .4 Trikon Systems
  - .5 Walravin BIS Yeti
  - .6 Ecofoot

## **2.10 ROOF MOUNTED PIPE SUPPORT**

- .1 Provide zero penetration pipe support on roof where indicated.
- .2 Base shall be made of high density polypropylene with UV protection. Maximum loading shall be 50 lb/sq.ft.
- .3 Frames shall be galvanized. All fastenings, rods, nuts, washers, hangers, etc. shall be stainless steel.
- .4 Provide shop drawings as specified. Install to manufacturers recommendations.
- .5 Acceptable material:
  - .1 Portable pipe hanger
  - .2 Bigfoot systems
  - .3 Miro rooftop supports
  - .4 Walravin BIS Yeti
  - .5 Ecofoot

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Roof support install in accordance with:
  - .1 Manufacturer's instructions and recommendations.
  - .2 Provide protection against deterioration due to contact of dissimilar metals.
- .2 Flashing Installation:
  - .1 Install roof support flashing in accordance with manufacturer's printed instructions.
- .3 Vibration Control Devices:
  - .1 Install as indicated and at all roof mounted equipment that is not internally isolated.
- .4 Clevis plates:
  - .1 Attach to concrete with 4 minimum concrete inserts at each corner.

- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

### 3.2 PIPE SUPPORT SPACING

- .1 Within 300 mm (12") of each elbow and:

Maximum Pipe Size: NPS	Spacing Steel	Maximum Spacing Copper
up to 32 mm (1 1/4")	2.1 m (7')	1.8 m (6')
40 mm (1 1/2")	2.7 m (9')	2.4 m (8')
50 mm (2")	3.0 m (10')	2.7 m (9')
65 mm (2 1/2")	3.6 m (12')	3.0 m (10')
80 mm (3")	3.6 m (12')	3.0 m (10')
90 mm (3 1/2")	3.9 m (13')	3.3 m (11')
100 mm (4")	4.2 m (14')	3.6 m (12')
125 mm (5")	4.8 m (16')	
150 mm (6")	5.1 m (17')	
200 mm (8")	5.7 m (19')	
250 mm (10")	6.6 m (22')	
300 mm (12")	6.9 m (23')	

- .2 Pipework greater than NPS 300 mm (12"): to MSS SP-69.
- .3 Gas and fuel oil piping: every 1.8 m (6').
- .4 **Flexible joint roll groove pipe: in accordance with table below, but not less than one support at joints.**

### 3.3 EXAMINATION

- .1 Report to the contractor in writing, defects of work prepared by other trades and other unsatisfactory site conditions. Verify site dimensions. Commencement of work will imply acceptance of prepared work.

### 3.4 ADJUSTING

- .1 Verify that all manufactured units have been installed in accordance with specifications and details and will function as intended. Adjust any items where necessary to ensure proper operation.

### 3.5 CLEANING

- .1 Clean manufactured units using materials and methods approved by manufacturer. Do not use cleaning techniques which could impair performance of the roofing system.

**END OF SECTION**

**Part 1            General**

**1.1            APPLICATION**

- .1      Seismic restraint is becoming more prominent with improved soil testing equipment. Seismic requirement is not site specific by geographical area but determined by site soil conditions.
- .2      Where the structural engineer or architect documents have  $I_e \cdot S_a(0.2) \cdot F_a < 3.5$  seismic is not required on the plumbing, HVAC, electrical, or fire protection systems.
- .3      Where the structural engineer or architect documents have  $I_e \cdot S_a(0.2) \cdot F_a \geq 3.5$  seismic is required on the plumbing, HVAC, electrical, or fire protection systems.
- .4      Seismic will always be required on fire protection systems when required by NFPA codes.
- .5      Seismic will always be required on any “Disaster Relief Building.” For example, hospitals, police stations, ambulance building, etc.
- .6      When it is unclear in the tender documents request information from the structural engineer or architect for clarification.

**1.2            SECTION INCLUDES**

- .1      Seismic Requirements for single rod hanger support for conduit, pipe and other similar systems.
- .2      Seismic Requirements for trapeze type supports for cable tray, conduit, pipe and other similar systems.
- .3      Seismic requirements for all equipment and piping.

**1.3            RELATED WORK SPECIFIED ELSEWHERE**

- .1      Vibration Isolation Measures.

**1.4            REFERENCE STANDARDS**

- .1      All codes, standards, etc. as referenced shall be the latest edition.
- .2      National Building Code of Canada (NBC).
- .3      Canadian Standards Association
  - .1      CSA S832, Seismic Risk Reduction of Operation and Functional Components (OFCs) of Buildings.
  - .2      CAN/CSA-S16.1 Limit States Design of Steel Structures
  - .3      CAN3-S136 Design of Cold Steel Structural Members
  - .4      CSA W47.1 Certification of Companies for Fusion Welding of Steel
  - .5      CSA W59 Welded Steel Construction
- .4      SMACNA Seismic Restraint Manual Guidelines for Mechanical Systems
- .5      Canadian Institute of Steel Construction

- .6 Canadian General Standards Board
- .7 Underwriter Laboratories of Canada
- .8 Workers Compensation Board of BC
- .9 American Society of Testing and Materials
  - .1 ASTM A653/S653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (galvannealed) by the Hot Dip Process.
  - .2 ASTM A879M Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface.
  - .3 ASTM A307 Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .4 ASTM A325M Specification for Structural Bolts, Heat Treated 830MPa Minimum Tensile Strength.
- .10 All local codes.
- .11 NFPA-13: Installation of Fire Sprinkler Systems.
- .12 FEMA: Federal Emergency Management Activity.
- .13 FEMA: Seismic Restraint Installation Manuals 412. 413 and 414
  - .1 FEMA 412: Installing Seismic Restraints for Mechanical Equipment
  - .2 FEMA 413: Installing Seismic Restraints for Electrical Equipment
  - .3 FEMA 414: Installing Seismic Restraints for Duct and Pipe
- .14 ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.).
- .15 ASHRAE Applications Handbook; Seismic and Wind Restraint Design Chapter.

## 1.5 DEFINITIONS

- .1  $A_v$ : Effective peak velocity related acceleration coefficient BOCA, SBC Code.
- .2  $S_1$ : Mapped Long Period Seismic Acceleration Coefficient IBC, TI-809-04, ASCE7.
- .3  $S_s$ : Mapped Short Period Seismic Acceleration Coefficient IBC, TI-809-04, ASCE7.
- .4  $v$ : Zonal Velocity Coefficient NBC-Canada.
- .5 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 VISCMA 102-2007: Static Qualification Standards for Obtaining a VISCMA Compliant Seismic Component Rating.
- .7  $Z$ : Seismic Zone defines Seismic Coefficient  $C_a$  used by UBC Code.

## 1.6 PERFORMANCE REQUIREMENTS

- .1 Design Ground Acceleration Coefficient ( $A_v$ ,  $S_s$ ,  $v$ , or  $Z$  depending on Code = X.XX).

- .2 (If IBC or TI-809-04) Design Long Period Ground Acceleration Coefficient ( $S_1 = X.XX$ ).
- .3 Design Soil Type = ( $S_a, S_b, S_c, S_d$ ) as appropriate. (If NBC Canada, the Foundation Factor).
- .4 Importance or Performance Factor appropriate to structure =  $I_p = X.XX$ .
- .5 If UBC Zone 4, Proximity to Fault and, if less than 10km, Fault Type.
- .6 Schedule or drawings indicating critical ( $I_p = 1.5$ ) Duct/Piping systems, including systems whose importance factor may be increased by proximity to critical components.

## 1.7 DESCRIPTION OF SYSTEM

- .1 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 HVAC 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.
- .2 The work under this section shall include furnishing all labour, materials, tools, appliances, and equipment, and performing all operations necessary for the complete execution of the installation of seismic snubber restraint assemblies as shown, detailed, and/or scheduled on the drawing and/or specified in this section of the specifications.
- .3 All seismic snubber restraint assemblies shall meet the following minimum requirements:
  - .1 The snubber/restrained isolator for isolated equipment shall include a resilient element that will ensure that no un-cushioned shock can occur (this does not include cable restraints).
  - .2 It shall be possible to visually inspect the resilient material for damage and allow for replacement, if necessary.
  - .3 All snubbers are to include a maximum air gap of 0.25 in (6 mm).
  - .4 Seismic restraint systems shall be designed to offer seismic restraint in all directions, unless otherwise noted.
  - .5 Seismic restraint capacities to be verified by an independent test laboratory or certified by a registered Professional Engineer to ensure that the design intent of this specification is realized. Verification shall be by one of the following methods:
    - .1 An NRTL (National Recognized Testing Laboratory), or laboratory recommended by VISCMA.
    - .2 Certified by a Professional Engineer with at least 5 years of experience, using industry standard methods of analysis, which employ common engineering practices. Adherence to the ratings standard within ASHRAE SPC171 and VISCMA 102-2007 is required.
    - .3 By a nationally recognized agency, such as VISCMA, that has reviewed and approved the restraint.

## **1.8 SYSTEM DESIGN**

- .1 Seismic restraint manufacturer shall be responsible for the structural design of 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 furnish, to the seismic restraint manufacturer, 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 furnished 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, ductwork and equipment is to be restrained to meet code requirements. At a minimum, the seismic restraint manufacturer 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 of the housekeeping pad is to be coordinated with the seismic restraint manufacturer to ensure that adequate edge distances exist in order to obtain the desired equipment anchor capacities.

## **1.9 SEISMIC BRACING AND SUPPORT DESIGN REQUIREMENTS**

- .1 Seismic restraint designer shall co-ordinate all attachments with the structural engineer of record.
- .2 Design analysis shall include calculated dead loads, static seismic loads, and capacity of materials utilized for the connection of the equipment or system to the structure.
- .3 Analysis shall detail anchoring methods, bolt diameter, and embedment depth.
- .4 All seismic restraint devices shall be designed to accept without failure the forces calculated per the applicable building code and as summarized in Section 3.01.
- .5 Friction from gravity loads shall not be considered resistance to seismic forces.
- .6 Fire protection systems shall meet the requirements of NFPA-13 and NFPA-14. Sway bracing used for seismic restraint purposes must be fitted with provisions to resist the vertical force component of the diagonal brace. Single diagonal brace for seismic restraint will not be approved.

## **1.10 ALTERNATE SYSTEMS**

- .1 Provisions of the General Conditions and Supplemental Conditions of the specifications shall govern the use of alternate systems to those specified.
- .2 Uncertified internal equipment seismic restraint systems are disallowed for use on this project.

### **1.11 QUALITY ASSURANCE**

- .1 The contractor shall provide pre-engineered seismic restraint systems to meet total design lateral force requirements for support and restraint of piping, conduit, cable trays and other similar systems and equipment where required by the applicable building code.
- .2 System Supports/Restraints: Firms regularly engaged in the manufacture of products of the types specified in this section, whose products have been in satisfactory use in similar service for not less than 5 years.
- .3 Bolted framing channels and fittings shall have the manufacturers name, part number, and material heat code identification number stamped in the part itself for identification. Material certification sheets and test reports must be made available by the manufacturer upon request.
- .4 Only companies experienced in performing the work of this section shall do the installation.
- .5 All seismic restraint installations shall be independently reviewed by the Owners Representative for compliance with project specifications.

### **1.12 SUBMITTALS**

- .1 Product Data: Include Seismic Rating Curve for each seismically rated isolator or restraint component.
- .2 Samples: The contractor shall submit samples of specified seismic snubber devices for approval.
- .3 Shop Drawings shall include the following:
  - .1 Design Calculations: Calculate requirements for selecting seismically rated vibration isolators and seismic restraints. Certification documents to be signed and sealed by a qualified Professional Engineer with at least 5 years of experience in the design of seismic restraints. Professional engineer shall have local jurisdiction and provide periodic field review and final certification upon completion of the project. All costs and fees associated with the engineering shall be the responsibility of this contractor.
  - .2 Vibration Isolation Bases: Dimensional drawings including anchorage and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads.
  - .3 Seismic-Restraint Details: Detailed submittal drawings of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors. Include ratings for loads.
  - .4 Equipment Manufacturer Seismic Qualification Certification: The Equipment Manufacturer must submit certification that each piece of provided equipment will withstand seismic forces identified in "Performance Requirements" Article above. Include the following:
    - .1 Basis for Certification: Indicate whether the "withstand" certification is based on actual test assembled components or on calculations.



- .2 Indicate the equipment is certified to be durable enough to:
  - .1 structurally resist the design forces and/or
  - .2 will remain functional after the seismic event.
- .5 Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- .6 Detailed description of the assumed equipment anchorage devices on which the certification is based.

#### **1.13 DELIVERY, STORAGE, AND HANDLING**

- .1 Deliver strut systems, pipe hangers and components carefully to avoid breakage, denting, and scoring finishes. Do not install damaged equipment.
- .2 Store strut systems, pipe hangers and components in original cartons and in clean dry space; protect from weather and construction traffic.

#### **1.14 WORK FURNISHED BUT NOT INSTALLED**

- .1 The materials and systems specified in this section shall be purchased by the HVAC contractor from a single seismic snubber restraint materials manufacturer to assure sole source responsibility for the performance of the seismic restraints used.
- .2 The materials and systems specified in this section can, at the contractor's option, be installed by the subcontractor who installs the seismic services.

#### **1.15 COORDINATION**

- .1 Coordinate size, shape, reinforcement and attachment of all housekeeping pads supporting seismically rated equipment. Concrete shall have a minimum compressive strength of 3,000 psi or as specified by the consultant.
- .2 Coordinate with seismic restraint manufacturer to locate and size structural supports underneath seismically restrained equipment (e.g. roof curbs, cooling towers, and other similar equipment).

#### **1.16 INSTALLATION**

- .1 Installation of all seismic restraint materials specified herein shall be accomplished following the manufacturer's written instructions. Installation instructions shall be submitted to the engineer for approval prior to the beginning of the work.

### **Part 2 Products**

#### **2.1 MATERIALS**

- .1 Unless otherwise specified materials used in the Work shall conform to the following:
  - .1 All steel rolled sections and steel plates shall conform to CAN/CSA G40.21M-300W
  - .2 All steel hollow structural steel sections shall conform to CAN/CSA G40.21-350W Class C

- .3 Structural steel bolts, nuts and washers shall conform to ASTM A325M
- .4 Weld electrodes shall be SMAW-E-E480XX and SAW-F480-EXXX.

## **2.2 ACCEPTABLE MANUFACTURERS**

- .1 All seismic snubbers and combination restraint/vibration isolation materials specified herein shall be provided by a single manufacturer to assure sole source responsibility for the proper performance of the materials used. Manufacturer is to be a member of VISCMA.
- .2 Anchor types and sizes are to be per the design data as provided by the seismic restraint manufacturer.
- .3 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 all requirements as listed in this specification.
- .4 Kinetics Noise Control Inc.
- .5 Cooper 'B' Line.
- .6 Unistrut Building Systems.
- .7 Mason Industries.

## **2.3 SEISMIC SNUBBER TYPES**

### **GENERAL**

(Isolator/Snubber Types contained herein are per ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.) Handbook, HVAC Applications, Seismic and Wind Restraint Design)

- .1 Type A, Coil Spring Isolator Incorporated Within a Ductile Iron or Cast Aluminum Housing.
  - .1 Cast iron or aluminum housings are brittle when subjected to shock loading and are therefore not approved for seismic restraint applications.
- .2 Type B, Coil Spring Isolator Incorporated Within A Steel Housing
  - .1 Spring isolators shall be seismic control restrained spring isolators, incorporating a single or multiple coil spring element, having all of the characteristics of free standing coil spring isolators as specified in the vibration isolation portion of this specification. Springs shall be restrained using a housing engineered to limit both lateral and vertical movement of the supported equipment during an earthquake without degrading the vibration isolation capabilities of the spring during normal equipment operating conditions.

- .2 Vibration isolators shall incorporate a steel housing and neoprene snubbing grommet system designed to limit motion to no more than  $\frac{1}{4}$ " (6 mm) in any direction and to prevent any direct metal-to-metal contact between the supported member and the fixed restraint housing. The restraining system shall be designed to withstand the seismic design forces in any lateral or vertical direction without yield or failure. Where the capacity of the anchorage hardware in concrete is inadequate for the required seismic loadings, a steel adapter base plate to allow the addition of more or larger anchors will be fitted to fulfill these requirements. In addition to the primary isolation coil spring, the load path will include a minimum  $\frac{1}{4}$ " (6 mm) thick neoprene pad.
  - .3 Spring elements shall be colour coded or otherwise easily identified. Springs shall have a lateral stiffness greater than 1.2 times the rated vertical stiffness and shall be designed to provide a minimum of 50% overload capacity. Non-welded spring elements shall be epoxy powder coated and shall have a minimum of a 1000-hour rating when tested in accordance with ASTM B-117.
  - .4 . To facilitate servicing, the isolator will be designed in such a way that the coil spring element can be removed without the requirements to lift or otherwise disturb the supported equipment.
  - .5 Spring isolators shall be Model FHS as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (2).
- .3 Type C, Coil Spring Isolator Incorporated Within a Steel Housing
- .1 Spring isolators shall be seismic control restrained spring isolators, incorporating one or more coil spring elements, having all the characteristics of free standing coil spring isolators per the vibration isolation section of this specification, for equipment which is subject to load variations and/or large external forces. Isolators shall consist of one or more laterally stable steel coil springs assembled into fabricated welded steel housings designed to limit movement of the supported equipment in all directions.
  - .2 Housing assembly shall be made of fabricated steel members and shall consist of a top load plate complete with adjusting and leveling bolts, adjustable vertical restraints, isolation washers, and a bottom load plate with internal non-skid isolation pads and holes for anchoring the housing to the supporting structure. Housing shall be hot dipped galvanized for outdoor corrosion resistance. Housing shall be designed to provide a constant free and operating height within  $\frac{1}{8}$ " (3 mm).
  - .3 The isolator housing shall be designed to withstand the project design seismic forces in all directions.
  - .4 Coil spring elements shall be selected to provide static deflections as shown on the vibration isolation schedule or as indicated or required in the project documents. Spring elements shall be colour coded or otherwise easily identified. Springs shall have a lateral stiffness greater than 1.2 times the rated vertical stiffness and shall be designed to provide a minimum of 50% overload capacity. Non-welded spring elements shall be epoxy powder coated and shall have a minimum of a 1000-hour rating when tested in accordance with ASTM B-117.

- .5 Spring isolators shall be Model FLS and FLSS as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (3).
- .4 Type D, Coil Spring Isolator Incorporated with Integral Seismic Restraint
  - .1 Spring isolators shall be single or multiple coil spring elements which have all of the characteristics of freestanding coil spring isolators as specified in the vibration isolation portion of this specification, incorporating lateral and vertically restrained seismic housing assemblies. Spring elements shall be readily replaceable without the need to list or remove the supported equipment.
  - .2 Restraint housing shall be sized to meet or exceed the force requirements of the application and shall have the capability of accepting coil springs of various sizes, capabilities, and deflections as required to meet the required isolation criteria. All spring forces shall be contained within the coil/housing assembly, and the restraint anchoring hardware shall not be exposed to spring generated forces under conditions of no seismic force. Spring element leveling adjustment shall be accessible from above and suitable for use with a conventional pneumatic or electric impact wrench.
  - .3 Restraint element shall incorporate a steel housing with elastomeric elements at all dynamic contact points. Elastomeric elements shall be replaceable. Restraint shall allow  $\frac{1}{4}$ " (6 mm) free motion in any direction from the neutral position. Restraint shall have an overturning factor (ratio of effective lateral snubber height to short axis anchor spacing) of 0.33 or less to ensure optimum anchorage capacity.
  - .4 Spring isolators shall be Model FMS as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (4).
- .5 Type E, All Direction Neoprene Isolator
  - .1 Vibration Isolators shall be neoprene, molded from oil resistant compounds, designed to operate within the strain limits of the isolator so to provide the maximum isolation and longest life expectancy possible using neoprene compounds. Isolators shall include encapsulated cast-in-place top steel load transfer plate for bolting to equipment and a steel base plate with anchor holes for bolting to the supporting structure. Ductile iron or cast aluminum components are not acceptable alternatives and shall not be used due to brittleness when subjected to shock loading.
  - .2 Isolator shall be capable of withstanding the design seismic loads in all directions with no metal-to-metal contact.
  - .3 Isolator shall have minimum operating static deflections as shown on the project Vibration Isolation Schedule or as otherwise indicated in the project documents and shall not exceed published load capacities.
  - .4 Neoprene isolators shall be Model RQ as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02 and 2.03 (5).

- .6 Type F, Light Capacity All Direction 3-Axis External Seismic Snubber Assembly
- .1 Equipment shall be restrained against excessive movement during a seismic event by the use of 3-axis resilient snubbers, designed to withstand the project required seismic forces. A minimum of two (2) snubbers are to be used at each equipment installation, oriented to effectively restrain the isolated equipment in all three directions, and additional snubbers shall be used as required by seismic design conditions.
  - .2 Snubbers shall be of interlocking steel construction and shall be attached to the equipment structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral and vertical equipment movement at each snubber location to a maximum of ¼" (6 mm) in any direction.
  - .3 Snubbers shall include a minimum ¼" (6 mm) thick resilient neoprene pads to cushion any impact and to avoid any potential for metal-to-metal contact. Maximum neoprene bearing pressure shall not exceed 1500 pounds / sq. inch (10.4 N / sq. mm). Snubber shall be capable of withstanding an externally applied seismic force of up to 3,000 pounds (1360 kg) in any direction. Snubber shall be installed only after the isolated equipment is mounted, piped, and operating so as to ensure that no contact occurs during normal equipment operation.
  - .4 Three-axis seismic snubbers shall be Model HS-5 as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and 2.01, 2.02, and 2.03 (6).
- .7 Type G, Lateral 2-Axis External Seismic Snubber Assembly
- .1 Equipment shall be restrained against excessive lateral movement during a seismic event by the use of 2-axis horizontal resilient snubbers, designed to withstand the project required seismic forces. A minimum of two (2) snubbers are to be used at each equipment installation, oriented to effectively restrain the isolated equipment in all horizontal directions, and additional snubbers shall be used as required by seismic design conditions.
  - .2 Snubbers shall be interlocking steel construction and shall be attached to the equipment structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral equipment movement at each snubber location to a maximum of ¼" (6 mm).
  - .3 Snubbers shall include a minimum of ¼" (6 mm) thick resilient neoprene pads to cushion any impact and to avoid any potential for metal-to-metal contact. Snubber shall be installed only after the isolated equipment is mounted, piped, and operating so as to ensure that no contact occurs during normal equipment operation.
  - .4 Two-axis lateral seismic snubbers shall be Model HS-2 as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (7).

- 
- .8 Type H, Heavy Capacity All Direction 3-Axis External Seismic Snubber Assembly
- .1 Equipment shall be restrained against excessive vertical and horizontal movement during a seismic event by the use of 3-axis resilient snubbers, designed to withstand the project required seismic forces. A minimum of two (2) snubbers are to be used at each equipment installation, oriented to effectively restrain the isolated equipment in all three directions, and additional snubbers shall be used as required by seismic design conditions.
  - .2 Snubbers shall be of welded interlocking steel construction and shall be attached to the equipment structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral and vertical equipment movement at each snubber location to a maximum of ¼" (6 mm) in any direction.
  - .3 Snubbers shall include resilient neoprene pads with a minimum thickness of ¼" (6 mm) to cushion any impact and to avoid any potential for metal-to-metal contact. Snubber shall be capable of withstanding an externally applied seismic force up to 10,000 pounds (4,540 kg) in any direction. Snubber shall be installed only after the isolated equipment is mounted, piped, and operating so as to ensure that no contact occurs during normal equipment operation.
  - .4 Three-axis seismic snubbers shall be Model HS-7 as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (8).
- .9 Type I, Horizontal 1-Axis External Seismic Snubber Assembly
- .1 Equipment shall be restrained against excessive horizontal one-axis movement during a seismic event by the use of single-axis resilient snubbers, designed to withstand the project required seismic forces. A minimum of four (4) snubbers are to be used at each equipment installation, oriented to effectively restrain the isolated equipment in all lateral directions.
  - .2 Snubbers shall be of steel construction and shall be attached to the equipment structure and equipment in a manner consistent with anticipated design loads. Snubbers shall limit lateral equipment movement at each snubber location in the direction of impact to a maximum of ¼" (6 mm).
  - .3 Snubbers shall include resilient neoprene pads with a minimum thickness of ¼" (6 mm) to cushion any impact and to avoid any potential for metal-to-metal contact. Snubber shall be installed only after the isolated equipment is mounted, piped, and operating so as to eliminate any contact during normal equipment operation.
  - .4 Single-axis seismic snubbers shall be Model HS-1 as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (9).
- .10 Type J, Cable Restraints for Suspended Piping and Ductwork
- .1 Seismic wire rope cable restraints shall consist of steel wire strand cables, sized to resist project seismic loads, arranged to offer seismic restraint capabilities for piping, ductwork, and suspended equipment in all lateral directions.

- .2 Building and equipment attachment brackets at each end of the cable shall be designed to permit free cable movement in all directions up to a 45-degree misalignment. Protective thimbles shall be used at sharp connection points as required to eliminate potential for dynamic cable wear and strand breakage.
- .3 Restraints shall be sized to the capacity of the cable or to the capacity of the anchorage, whichever is lesser.
- .4 Seismic wire rope connections shall be made using overlap wire rope “U” clips or seismically rated tool-less wedge insert lock connectors.
- .5 Vertical suspension rods shall be braced as required to avoid potential for buckling due to vertical “up” forces. Braces shall be structural steel angle uniquely selected to be of sufficient strength to prevent support rod bending. Brace shall be attached to the vertical suspension rod by a series of adjustable straps. Clips shall be capable of securely locking brace to suspension rod without the need for hand tools.
- .6 Where clevis hanger brackets are used for seismic restraint attachment, they will be fitted with clevis internal braces to prevent buckling of the hanger brackets.
- .7 Seismic cable shall be as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.03 through 1.07 inclusive, and sections 2.01, 2.02, and 2.03 (10).
- .8 Seismic cable building and equipment attachment brackets shall be Model KSCA, KSCU, or KSCC as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (10).
- .9 Seismic cable concrete anchor bolts shall be Model KCAB Wedge, Model KCCAB Cracked Concrete, or Model KUAB Undercut, as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (10).
- .10 Seismic wire rope connectors shall be (Model KWRC - 'U' clamp) / (Model KWGC - Tool-less wedge lock) as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (10).
- .11 Seismic vertical suspension stiffener rod clips shall be Model KHRC as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (10).
- .12 Clevis Internal Braces shall be Model KCHB as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed in sections 1.04 through 1.09 inclusive, and sections 2.01, 2.02, and 2.03 (10).

## **2.4 SEISMIC BRACING COMPONENTS**

- .1 Steel strut shall be 1-5/8 wide in varying heights and mig-welded combinations as required to meet load capacities and designs. A material heat code, part number, and manufacturer's name shall be stamped on all strut and fittings to maintain traceability to material test reports.

- .2 Material for epoxy painted strut: ASTM A1011, SS, Grade 33.
- .3 Material for pre-galvanized strut: ASTM A653, SS, Grade 33.
- .4 Material for hot-dip galvanized strut: ASTM A1011, SS, Grade 33 and hot-dip galvanized after fabrication in accordance with ASTM A123.
- .5 Material for fittings and accessories: ASTM A907, Grade 33, Structural Quality or ASTM A1011, SS, Grade 33.
- .6 Fittings and accessories: Products shall be of the same manufacturer as strut and designed for use with that product.

## **2.5 UNIFORM BUILDING CODE REQUIREMENTS**

- .1 Seismic Zone Factor to Table 16-I for area of jurisdiction.
- .2 Soil Profile Type to Table 16-J for area of jurisdiction.
- .3 Seismic Importance Factor to Table 16-K for area of jurisdiction.
- .4 Component Amplification Factor to Table 16-O for area of jurisdiction.
- .5 Component Response Mod. Factor to Table 16-O for area of jurisdiction.
- .6 Seismic Coefficient to Table 16-Q for area of jurisdiction.
- .7 The total height of the structure ( $h_t$ ) and the height of the system to be restrained within the structure ( $h_x$ ) shall be determined in co-ordination with architectural plans and the General Contractor.
- .8 Forces shall be calculated for individual supports using the above information. Exceptions to Table 16-O may be utilized. However, all use of exceptions shall be noted on submitted seismic bracing plan documents.

## **Part 3 Execution**

### **3.1 GENERAL INSTALLATION**

- .1 Installation of all seismic restraint materials specified in this section shall be accomplished as per the manufacturer's written instructions.
- .2 Refer to FEMA Manuals 412, 413, and 414 for typical industry standard installation guidelines.
- .3 Upon completion of installation of all seismic restraint materials and before start-up of restrained equipment, all debris shall be cleaned from beneath all protected equipment, leaving equipment free to contact snubbers/restraints.
- .4 Torque anchor bolts according to anchor manufacturer's written instructions to resist seismic forces.
- .5 All seismic restraint systems shall be installed in strict accordance with the manufacturer's seismic restraint guidelines manual and all certified submittal data.
- .6 Prior to installation, bring to the architect's/engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.



- .7 Brace support rods when necessary to accept compressive loads. Welding of compressive braces to the vertical support rods is not acceptable.
- .8 Seismic restraints shall be attached to the structural system. Looping restraints around the system is not acceptable.
- .9 Do not brace a system to two independent structures such as ceiling and wall.
- .10 Provide appropriately sized openings in walls, floors, and ceilings for anticipated seismic movement. Provide fire seal systems in fire-rated walls.
- .11 Seismic restraint cables shall be adjusted such that they are not visibly slack, or the flexibility is approximately 25mm under thumb pressure for a 1500mm cable length (equivalent ratio for other cable lengths).
- .12 All seismic restraint cables shall be at least 25mm clear of all other equipment and services.

### **3.2 EQUIPMENT INSTALLATION**

- .1 All external utility connections to restrained equipment shall be designed to allow differential seismic motion without damage to the equipment or utility connections.
- .2 Adjust isolators and restraints after piping systems have been filled and equipment is at its operating weight, following the manufacturer's written instructions.
- .3 After equipment installation is completed, adjust limit stops following manufacturer's written instructions so that they are out of contact during normal operation.
- .4 Adjust snubbers according to manufacturer's written instructions.
- .5 Installation of seismic restraints shall not cause any change in position of equipment, resulting in stresses or misalignment.
- .6 No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration isolation system specified.
- .7 Do not install any seismic restraint for equipment, cable trays or conduit that compromises isolation specified.

### **3.3 PIPING INSTALLATION**

- .1 Hold down clamps must be used to attach pipe to all trapeze members before applying restraints.
- .2 Branch lines may not be used to restrain main lines.
- .3 Piping crossing building seismic or expansion joints, passing from building to building, or supported from different portions of the building shall be installed to allow differential support displacements without damaging the pipe, equipment connections, or support connections. Pipe offsets, loops, anchors, and guides shall be installed as required to provide specified motion capability and limit motion of adjacent piping.
- .4 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.

### **3.4 FASTENING TO STRUCTURE**

- .1 Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast in place inserts, or wedge-type concrete anchors. Consult structural engineer of record.
- .2 Overstressing of the building structure shall not occur from overhead support of equipment. Bracing attached to structural members may present additional stresses. The contractor shall submit loads to the structural engineer of record for approval in this event.
- .3 Coring is not permitted for the installation of concrete anchors. Use ground penetrating radar or equivalent method of embedment item detection to locate all embed items including reinforcing steel and electrical conduits. Concrete reinforcing steel and electrical conduits shall not be cut or damaged under any circumstances.
- .4 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.
- .5 If mounting hole diameter exceeds bolt diameter by more than 0.125" (3 mm), reduce clearance in hole with epoxy grout, flanged elastomeric bushings or welded washer.
- .6 Housekeeping Pads must be adequately reinforced and adequately sized for proper installation of equipment anchors. Refer to seismic restraint manufacturer's written instructions.

### **3.5 INSPECTION**

- .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 Upon completion of the installation of all seismic restraint devices herein specified, the local representative of the seismic restraint manufacturer shall, at the contractor's request, inspect the completed system and report in writing any installation errors, improperly selected snubber devices, or other fault in the system which could affect the performance of the system.
- .3 The installing contractor shall submit a report upon request 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.

### **3.6 PIPING**

- .1 Seismically restrain all piping listed below. Use Type J Cable Restraints for all piping supported by vibration isolation hanger assemblies, including:
  - .1 Natural gas piping, medical gas piping, vacuum piping, petroleum based liquid piping, and compressed air piping equal to or greater than 1" (25 mm) in inside diameter.

- .2 Brace remainder of piping to code requirements (IBC or TI-809-04) on in conformance with SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.) "Seismic Restraint Manual Guidelines for Mechanical Systems", Second Edition (Remaining Codes).

### **3.7 DUCTWORK**

- .1 Seismically restrain all ductwork listed below. Use Type J Cable Restraints for all ductwork supported by vibration isolation hanger assemblies, including:
  - .1 All rectangular and oval ducts with cross sectional area equal to or greater than 6 sq. ft. (0.55 sq. meters).
  - .2 All round ducts with diameters equal to or greater than 32" (812 mm).
  - .3 Brace remaining ductwork to code requirements (IBC or TI-809-04) or in conformance with SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.) "Seismic Restraint Manual Guidelines for Mechanical Systems", Second Edition (Remaining Codes).

### **3.8 CONDUIT**

- .1 Seismically restrain all electrical conduit listed below. Use Type J Cable Restraints for all conduit supported by vibration isolation hanger assemblies, including:
  - .1 All round ducts with diameters equal to or greater than 32" (812 mm).
  - .2 Brace all conduit to code requirements (IBC or TI-809-04) or in conformance with SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.) "Seismic Restraint Manual Guidelines for Mechanical Systems", Second Edition (Remaining Codes).

### **3.9 FIRE PROTECTION PIPING**

- .1 Fire protection, sprinkler piping, and related equipment is considered as "Life Safety Equipment" and is to be seismically restrained per guidelines as published by NFPA (National Fire Protection Association).

### **3.10 ROOF MOUNTED EQUIPMENT**

- .1 Provide seismic restraint for all isolated and non-isolated roof curbs and associated equipment.
- .2 Provide seismically restrained steel coil spring isolation systems where isolation curbs are indicated and non-isolated seismic restraints for all other roof curb systems."

**END OF SECTION**

**Part 1 General**

**1.1 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with general requirements.
- .2 Provide separate shop drawings for each isolated system complete with performance and product data.

**Part 2 Products**

**2.1 GENERAL**

- .1 Size and shape of bases type and performance of vibration isolation to be as indicated.
- .2 To be of the same manufacturer for all isolation.
- .3 Acceptable materials:
  - .1 Korfund
  - .2 Vibro-Acoustics
  - .3 Vibron

**2.2 ELASTOMERIC PADS**

- .1 Type EP1 - neoprene waffle or ribbed; 10 mm (3/8") minimum thick; 50 durometer; maximum loading 350 kPa (50.8 psi).
- .2 Type EP2 - rubber waffle or ribbed; 10 mm (3/8") minimum thick; 30 durometer natural rubber; maximum loading 415 kPa (60.2 psi).
- .3 Type EP3 - neoprene-steel-neoprene; 10 mm (3/8") minimum thick neoprene bonded to 1.5 mm (16 gauge) steel plate; 50 durometer neoprene, waffle or ribbed; holes sleeved with isolation washers; maximum loading 350 kPa (50.8 psi).
- .4 Type EP4 - rubber-steel-rubber; 10 mm (3/8") minimum thick rubber bonded to 1.5 mm (16 gauge) steel plate; 30 durometer natural rubber, waffle or ribbed; holes sleeved with isolation washers; maximum loading 415 kPa (60.2 psi).
- .5 Acceptable materials:
  - .1 Korfund
  - .2 IAC Acoustics
  - .3 Vibro-Acoustics
  - .4 Vibron

**2.3 ELASTOMERIC MOUNTS**

- .1 Type M1 - colour coded; neoprene in shear; maximum durometer of [60]; threaded insert and two bolt-down holes; ribbed top and bottom surfaces.

- .2 Acceptable materials:
  - .1 Vibro-Acoustics
  - .2 Korfund
  - .3 IAC Acoustics
  - .4 Vibron

## **2.4 SPRINGS**

- .1 Design stable springs so that ratio of lateral to axial stiffness is equal to or greater than 1.2 times the ratio of static deflection to working height. Select for 50% travel beyond rated load. Units to be complete with levelling devices.
- .2 Ratio of height when loaded to diameter of spring to be between 0.8 to 1.0.
- .3 Cadmium plate for all installations.
- .4 Colour code springs.

## **2.5 SPRING MOUNT**

- .1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.
- .2 Type M2 - stable open spring: support on bonded 6 mm (1/4") minimum thick ribbed neoprene or rubber friction and acoustic pad.
- .3 Type M3 - stable open spring: 6 mm (1/4") minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; leveling bolt for rigidly mounting to equipment.
- .4 Type M4 - restrained stable open spring: supported on bonded 6 mm (1/4") minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.
- .5 Type M5 - enclosed spring mounts with snubbers for isolation up to 950 kg (2100 lbs) maximum.
- .6 Performance: as indicated.
- .7 Acceptable materials:
  - .1 Korfund
  - .2 IAC Acoustics
  - .3 Vibron
  - .4 Vibro-Acoustics

## **2.6 HANGERS**

- .1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30° arc without metal to metal contact.
- .2 Type H1 - neoprene - in-shear, molded with rod isolation bushing, which passes through hanger box.
- .3 Type H2 - stable spring, elastomeric washer, cup with molded isolation bushing which passes through hanger box.

- .4 Type H3 - stable spring, elastomeric element with pre-compression washer and nut with deflection indicator.
- .5 Performance as indicated.
- .6 Acceptable materials:
  - .1 Vibron
  - .2 IAC Acoustics
  - .3 Korfund
  - .4 Vibro-Acoustics

## **2.7 ACOUSTIC BARRIERS FOR ANCHORS AND GUIDES**

- .1 Acoustic barriers: between pipe and support, consisting of 25 mm (1") minimum thick heavy-duty duct and neoprene isolation material.
- .2 Acceptable materials:
  - .1 Vibron
  - .2 IAC Acoustics
  - .3 Vibro-Acoustics

## **2.8 HORIZONTAL THRUST RESTRAINT**

- .1 Spring and elastomeric element housed in box frame; assembly complete with rods and angle brackets for equipment and ductwork attachment; provision for adjustment to limit maximum start and stop movement to 10 mm (3/8").
- .2 Arrange restraints symmetrically on either side of unit and attach at centerline of thrust.
- .3 Acceptable materials:
  - .1 Korfund
  - .2 IAC Acoustics
  - .3 Vibron
  - .4 Vibro-Acoustics

## **2.9 STRUCTURAL BASES**

- .1 Type B1 - Prefabricated steel base: integrally welded on sizes up to 2400 mm (96") on smallest dimension, split for field welding on sizes over 2400 mm (96") on smallest dimension and reinforced for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; pre-drilled holes to receive equipment anchor bolts; and complete with adjustable built-in motor slide rail where indicated.
- .2 Type B2 - Steel rail base: structural steel, positioned for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; and pre-drilled holes to receive equipment anchor bolts.
- .3 Bases to clear housekeeping pads by 25 mm (1") minimum.

- .4 Acceptable materials:
  - .1 Korfund
  - .2 IAC Acoustics
  - .3 Vibron
  - .4 Vibro-Acoustics

## **2.10 ROOF CURB ISOLATION RAIL**

- .1 General: complete factory assembled without need for sub-base.
- .2 Lower member: continuous extruded aluminum channel.
- .3 Upper member: continuous extruded aluminum channel to provide continuous support for equipment, complete with all-directional neoprene rubber bushings 6 mm (1/4") thick to resist wind and seismic forces.
- .4 Springs: steel, adjustable, removable, selected for 25 mm (1") maximum static deflection plus 50% additional travel to solid, cadmium plated, sized and positioned to ensure uniform deflection.
- .5 High frequency isolation: 6 mm (1/4") minimum thick continuous gasket on top and bottom of complete assembly or pads on top and bottom of each spring. Material: closed cell neoprene.
- .6 Weatherproofing: continuous flexible counterflashing to curb and providing access to springs. Material: aluminum.
- .7 Hardware: cadmium plated or galvanized.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.
- .2 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
- .3 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm (1") minimum static deflection as follows:
  - .1 Up to NPS 100 mm (4"): first 3 points of support. NPS 125 mm (5") to NPS 200 mm (8"): first 4 points of support. NPS 250 mm (10") and Over: first 6 points of support.
  - .2 First point of support shall have a static deflection of twice deflection of isolated equipment, but not more than 50 mm (2").
- .4 Where isolation is bolted to floor use vibration isolation rubber washers.

- .5 Block and shim level bases so that ductwork and piping connections can be made to a rigid system at the operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

### **3.2 SITE VISIT**

- .1 Manufacturer to visit site and provide written certification that installation is in accordance with manufacturer's instructions and submit report to Consultant.
- .2 Provide Consultant with notice 24 h in advance of visit.
- .3 Make adjustments and corrections in accordance with written report.

### **3.3 TESTING**

- .1 Experienced and competent sound and vibration testing professional engineer to take vibration measurement for HVAC systems after start up and TAB of systems to Testing Adjusting and Balancing Section.
- .2 Vibration measurements shall be taken for equipment-listed below:
- .3 Provide Consultant with notice 48 h in advance of commencement of tests.
- .4 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations including sound curves.
- .5 Submit complete report of test results including sound curves.

**END OF SECTION**



**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 Canadian General Standards Board (CGSB).
  - .1 CAN/CGSB-1.60, Interior Alkyd Gloss Enamel.
  - .2 CAN/CGSB-24.3, Identification of Piping Systems.
- .3 Canadian Standards Association (CSA).
  - .1 Natural Gas and Propane Installation Code CSA B149.1.
- .4 National Fire Protection Association
  - .1 NFPA 13, Installation of Sprinkler Systems.
  - .2 NFPA 14, Standpipe and Systems.

**1.2            PRODUCT DATA**

- .1 Submit product data in accordance with General Requirements.
- .2 Product data to include paint colour chips, all other products specified in this section.

**1.3            PRODUCT LITERATURE**

- .1 Submit product literature in accordance with General Requirements.
- .2 Product literature to include nameplates, labels, tags, lists of proposed legends.

**Part 2            Products**

**2.1            MANUFACTURER'S EQUIPMENT NAMEPLATES**

- .1 Metal or plastic lamicoid nameplate mechanically fastened to each piece of equipment by manufacturer.
- .2 Lettering and numbers to be raised or recessed.
- .3 Information to include, as appropriate:
  - .1 Equipment: Manufacturer's name, model, size, serial number, capacity.
  - .2 Motor: voltage, Hz, phase, power factor, duty, frame size.

**2.2            SYSTEM NAMEPLATES**

- .1 Colours:
  - .1 Hazardous: red letters, white background.
  - .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).

- .2 Construction:
- .1 3 mm (1/8") thick laminated plastic, matte finish, with square corners, letters accurately aligned and machine engraved into core.

.3 Sizes:

- .1 Conform to following table:

Size	No. of Sizes mm (")	Height of Line mm (")	Letters mm (")
1	10 x 50 (3/8" x 2")	1 (3/64")	3 (1/8")
2	15 x 75 (1/2" x 3")	1 (3/64")	6 (1/4")
3	15 x 75 (1/2" x 3")	2 (5/64")	3 (1/8")
4	20 x 100 (3/4" x 4")	1 (3/64")	10 (3/8")
5	20 x 100 (3/4" x 4")	2 (6/64")	6 (1/4")
6	20 x 200 (3/4" x 8")	1 (3/64")	10 (3/8")
7	25 x 125 (1" x 5")	1 (3/64")	15 (1/2")
8	25 x 125 (1" x 5")	2 (5/64")	10 (3/8")
9	32 x 200 (1¼" x 8")	1 (3/64")	20 (3/4")

- .2 Use maximum of 25 letters/numbers per line.

.4 Locations:

- .1 Terminal cabinets, control panels: Use size #5.
- .2 Equipment in Mechanical Rooms: Use size #9.
- .3 Roof top equipment: use size #9.
- .4 Equipment above ceiling: use size #1 riveted to ceiling suspension system.

## 2.3 FIRE DAMPER/FIRE STOP FLAP NAMEPLATES/FIRE SMOKE DAMPER

.1 Colours:

- .1 Black letters, yellow background.

.2 Construction:

- .1 Self adhesive 50 mm x 25 mm, matte finish, with round corners.

.3 Locations:

- .1 Install on adjacent ceiling grid. Where fire stop flap is installed in gypsum ceiling install on diffuser/grille frame. Where fire damper is installed above gypsum ceiling install on adjacent wall.

## 2.4 EXISTING IDENTIFICATION SYSTEMS

- .1 Apply existing identification system to new work.
- .2 Where existing identification system does not cover for new work, use identification system specified this section.
- .3 Before starting work, obtain written approval of identification system from Consultant.

- .4 Upon completion of this project all references to room names and numbering shall be to the Owner's requirements which may or may 'NOT' be the numbering system used on the drawings. Each contractor shall verify the proper numbering scheme to be used prior to project completion.
- .5 All equipment shall be identified in sequence from the existing equipment and "NOT" duplicate numbering of equipment.

## **2.5 PIPING SYSTEMS GOVERNED BY CODE**

- .1 Identification:
  - .1 Natural and propane gas: To CSA B149.1-00 and authority having jurisdiction and as indicated elsewhere.
  - .2 Sprinklers: To NFPA 13.
  - .3 Standpipe and hose systems: To NFPA 14.

## **2.6 IDENTIFICATION OF PIPING SYSTEMS**

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
- .2 Legend:
  - .1 Block capitals to sizes and colours listed in CAN/CGSB-24.3.
- .3 Arrows showing direction of flow:
  - .1 Outside diameter of pipe or insulation less than 75 mm (3"): 100 mm (4") long x 50 mm (2") high.
  - .2 Outside diameter of pipe or insulation 75 mm (3") and greater: 150 mm (6") long x 50 mm (2") high.
  - .3 Use double-headed arrows where flow is reversible.
- .4 Extent of background colour marking:
  - .1 To full circumference of pipe or insulation.
  - .2 Length to accommodate pictogram, full length of legend and arrows.
- .5 Materials for background colour marking, legend, arrows:
  - .1 Pipes and tubing 20 mm (3/4") and smaller: Waterproof and heat-resistant pressure sensitive plastic marker tags.
  - .2 All other pipes: Pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150°C (300°F) and intermittent temperature of 200°C (395°F).

**.6 Colours and Legends:**

- .1 Where not listed, obtain direction from Consultant.
- .2 Colours for legends, arrows: To following table:  

Background colour:	Legend:	Arrows:
Yellow	White	Black
Green	White	Black
Red	White	Black

**.7 Pictograms:**

- .1 **Where required, to Workplace Hazardous Materials Information System (WHMIS) regulations.**

**.8 Background colour marking and legends for piping systems:**

CONTENTS	BACKGROUND COLOUR MARKING	LEGEND
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
Make-up water	Yellow	MAKE-UP WTR
Condensate	Green	CONDENSATE
Natural gas	Yellow	NATURAL GAS
Gas regulator vents		to Codes
Conduit for low voltage		
Control wiring	White	CONTROL WIRING ___ VOLTS

**2.7 IDENTIFICATION DUCTWORK SYSTEMS**

- .1 50 mm (2") high stencilled letters and directional arrows 150 mm (6") long x 50 mm (2") high.
- .2 Colours: Black, or co-ordinated with base colour to ensure strong contrast.

**2.8 VALVES, CONTROLLERS**

- .1 Brass tags with 15 mm (1/2") stamped identification data filled with black paint.
- .2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.
- .3 Provide adhesive coloured tab (max. size 15 mm) indication on ceiling to locate valves/equipment above. Same applies to grid. Colour to be approved by consultant.

## **2.9 CONTROLS COMPONENTS IDENTIFICATION**

- .1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.
- .2 Inscriptions to include function and (where appropriate) fail-safe position.
- .3 Provide equipment identification and/or indication on ceiling to locate devices/equipment above ceiling. Install identification on grid. Colours to be approved by consultant.

## **2.10 LANGUAGE**

- .1 Identification to be in English.

## **Part 3 Execution**

### **3.1 TIMING**

- .1 Provide identification only after all painting specified has been completed.

### **3.2 INSTALLATION**

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Provide ULC and/or CSA registration plates as required by respective agency.

### **3.3 NAMEPLATES**

- .1 Locations:
  - .1 In conspicuous location to facilitate easy reading and identification from operating floor.
- .2 Standoffs:
  - .1 Provide for nameplates on hot and/or insulated surfaces.
- .3 Protection
  - .1 Do not paint, insulate or cover in any way.

### **3.4 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS**

- .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels not more than 1.7 m (5'-8") intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
- .2 Adjacent to each change in direction.
- .3 At least once in each small room through which piping or ductwork passes.
- .4 On both sides of visual obstruction or where run is difficult to follow.
- .5 On both sides of separations such as walls, floors, partitions.
- .6 Where system is installed in pipe chases, ceiling spaces, galleries, other confined spaces, at entry and exit points, and at each access opening.

- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 At point immediately upstream of major manually operated or automatically controlled valves, dampers, etc. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification to be easily and accurately readable from usual operating areas and from access points.
  - .1 Position of identification to be approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

### **3.5 VALVES, CONTROLLERS**

- .1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.
- .2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Consultant. Provide one copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively. Where existing numbering system is installed start new numbering system at 100.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ANSI/ASME B31.1, Power Piping.
- .3 ANSI/ASME Boiler and Pressure Vessel Code:
  - .1 Section 1: Power Boilers.
  - .2 Section V: Nondestructive Examination.
  - .3 Section IX: Welding and Brazing Qualifications.
- .4 CSA W47.2, Certification of Companies for Fusion Welding of Aluminum.
- .5 CSA W48, Filler Metals and Allied Metals for Arc Welding.
- .6 CSA B51, Boiler, Pressure Vessel and Pressure Piping Code.
- .7 CAN/CSA-W117.2, Safety in Welding, Cutting and Allied Processes.
- .8 CSA W178.1, Certification of Welding Inspection Organizations.
- .9 CSA W178.2, Certification of Welding Inspectors.
- .10 AWS B2.1, Specification for Welding Procedure and Performance Qualification.
- .11 AWS C1.1, Recommended Practices for Resistance Welding.
- .12 AWS W1, Welding Inspection.
- .13 ANSI/AWWA C206, Field Welding of Steel Water Pipe.

**1.2            WELDERS QUALIFICATIONS**

- .1 Welding qualifications to be in accordance with CSA B51.
- .2 Use qualified and licensed welders possessing certificate for each procedure to be performed from authority having jurisdiction.
- .3 Furnish welder's qualifications to Consultant.
- .4 Each welder to possess identification stamp issued by authority having jurisdiction.
- .5 Certification of companies for fusion welding of aluminum to be in accordance with CSA W47.2.

**1.3            INSPECTORS QUALIFICATIONS**

- .1 Inspectors to be qualified to CSA W178.2.

**1.4            WELDING PROCEDURES**

- .1 Registration of welding procedures in accordance with CSA B51.
- .2 Copy of welding procedures to be available for inspection at all times.

- .3 Safety in welding, cutting and allied processes to be in accordance with CAN/CSA-W117.2.

## **Part 2 Products**

### **2.1 ELECTRODES**

- .1 Electrodes: in accordance with CSA W48 Series.

## **Part 3 Execution**

### **3.1 WORKMANSHIP**

- .1 Welding to be in accordance with ANSI/ASME B31.1, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1, and applicable requirements of provincial authority having jurisdiction.
- .2 Protect all adjacent areas.

### **3.2 INSTALLATION REQUIREMENTS**

- .1 Identify each weld with welder's identification stamp.
- .2 Backing rings:
  - .1 Where used, fit to minimize gaps between ring and pipe bore.
  - .2 Do not install at orifice flanges.
- .3 Fittings:
  - .1 NPS 50 mm (2") and smaller: install welding type sockets.
  - .2 Branch connections: install welding tees or forged branch outlet fittings.

### **3.3 INSPECTION AND TESTS - GENERAL REQUIREMENTS**

- .1 Review all weld quality requirements and defect limits of applicable codes and standards with Consultant before any work is started.
- .2 Formulate "Inspection and Test Plan" in co-operation with Consultant.
- .3 Do not conceal welds until they have been inspected, tested and approved by inspector.
- .4 Provide for inspector to visually inspect all welds during early stages of welding procedures in accordance with AWS W1. Repair or replace all defects as required by codes and as specified herein.

### **3.4 SPECIALIST EXAMINATIONS AND TESTS**

- .1 General.
  - .1 Perform examinations and tests by specialist qualified in accordance with CSA W178.1 and CSA W178.2 and approved by Consultant.



- .2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
- .3 Inspect and test 25% of welds in accordance with "Inspection and Test Plan" by non-destructive visual examination and magnetic particle (hereinafter referred to as "particle") tests and/or full gamma ray radiographic (hereinafter referred to as "radiography") tests as specified.
- .2 Hydrostatically test all welds to requirements of ANSI/ASME B31.1.
- .3 Visual examinations: include entire circumference of weld externally and (wherever possible) internally.
- .4 Failure of visual examinations:
  - .1 Upon failure of any weld by visual examination, perform additional testing as directed by Consultant of a total of up to 10% of all welds, selected at random by Consultant by radiographic tests.

### **3.5 DEFECTS CAUSING REJECTION**

- .1 As described in ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessels Code.
- .2 In addition, hydronic water systems:
  - .1 Undercutting greater than 0.8 mm (1/32") adjacent to cover bead on outside of pipe.
  - .2 . Undercutting greater than 0.8 mm (1/32") adjacent to root bead on inside of pipe.
  - .3 Undercutting greater than 0.8 mm (1/32") at combination of internal surface and external surface.
  - .4 Incomplete penetration and incomplete fusion greater than total length of 40 mm (1 1/2") in any 1500 mm (60") length of weld depth of such defects being greater than 0.8 mm (1/32").
  - .5 Repair all cracks and defects in excess of 0.8 mm (1/32") in depth.
  - .6 Repair defects whose depth cannot be determined accurately on the basis of visual examination or particle tests.

### **3.6 REPAIR OF WELDS WHICH FAILED TESTS**

- .1 Re-inspect and re-test repaired or re-worked welds at Contractor's expense.

### **3.7 CLAIMS AGAINST OWNER FOR DELAYS**

- .1 Claims against Owner for delays in completion of project will not be entertained for reasons of failures of welds to pass examinations.

### **3.8 OCCUPIED AREAS**

- .1 Do not do any "Hot Work" in occupied areas.
- .2 Obtain "Hot Work" permits for working in existing building.

**END OF SECTION**

**Part 1            General**

**1.1            GENERAL**

- .1      TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do all other work as specified in this section including all air handling systems and equipment, all plumbing systems and equipment and all temperature controls system, building automation systems and equipment.
- .2      This contractor must co-ordinate their work with that of the TAB contractor.

**1.2            QUALIFICATIONS OF TAB AGENCIES**

- .1      Names of all personnel it is proposed to perform TAB to be submitted to and approved by Consultant within 30 days of start of work.
- .2      Provide documentation confirming qualifications, successful experience.
- .3      Only the following NEBB (National Environmental Balancing Bureau) TAB contractors may quote:

**GROUP A – STANDARD NEBB**

- .1      Air Audit Inc.  
110 Turnbull Court, Unit 11  
Cambridge, Ontario  
N1T 1K6  
(519) 740-0871
- .2      Air Velocities Control Ltd.  
100 Premium Way  
Mississauga, Ontario  
L5B 1A2  
(905) 279-4433
- .3      Flowset Balancing Ltd.  
431 Willis Dr.  
Oakville, Ontario  
L6L 4V6  
(416) 410-9793
- .4      Air Adjustments & Balancing Inc.  
P.O. Box 176,  
Schomberg, Ontario  
L0G 1T0  
(416) 254-3004

### **1.3 PURPOSE OF TAB**

- .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 (95% design) and low (75% of design) loads using actual or simulated loads. TAB contractor to perform equipment evaluation upon start up and once during each season in the first year of operation.
- .2 Adjust and regulate equipment and systems so as to meet specified performance requirements and to achieve specified interaction with all other related systems under all normal and emergency loads and operating conditions. Confirm all equipment interlocks and functions of associated systems.
- .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges and temperatures. Refer to BAS for system operating functions.

### **1.4 EXCEPTIONS**

- .1 TAB of systems and equipment regulated by codes, standards to be to satisfaction of authority having jurisdiction.

### **1.5 CO-ORDINATION**

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule so as to ensure completion before acceptance of project.
- .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems. Co-ordinate with other trades to ensure all systems are interlocked as indicated elsewhere prior to TAB.

### **1.6 PRE-TAB REVIEW**

- .1 Review contract documents before project construction is started and confirm in writing to Consultant adequacy of provisions for TAB and all other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Consultant in writing all proposed procedures which vary from standard.
- .3 During construction, co-ordinate location and installation of all TAB devices, equipment, accessories, measurement ports and fittings.
- .4 During construction indicate all tolerances of piping, ductwork etc conforms to specifications.

### **1.7 START-UP**

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .2 Follow special start-up procedures specified elsewhere in the Mechanical Division.

---

**1.8 OPERATION OF SYSTEMS DURING TAB**

- .1 Operate systems for length of time required for TAB and as required by Consultant for verification of TAB reports.

**1.9 START OF TAB**

- .1 Notify Consultant in writing 3 days prior to start of TAB.
- .2 Start TAB only when building is essentially completed, including:
  - .1 Installation of ceilings, doors, windows, other construction affecting TAB.
  - .2 Application of weather-stripping, sealing, caulking.
  - .3 All pressure, leakage, other tests specified elsewhere in the Mechanical Division.
  - .4 All provisions for TAB installed and operational.
  - .5 Start-up, verification for proper, normal and safe operation of all mechanical and associated electrical and control systems affecting TAB including but not limited to:
    - .1 Proper thermal overload protection in place for electrical equipment.
    - .2 Air systems:
      - .1 Filters in place, clean.
      - .2 Duct systems clean.
      - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
      - .4 Correct fan rotation.
      - .5 Fire, smoke, volume control dampers installed and open.
      - .6 Coil fins combed, clean.
      - .7 Access doors, installed, closed.
      - .8 All outlets installed, volume control dampers open.
    - .3 Liquid systems:
      - .1 Flushed, filled, vented.
      - .2 Correct pump rotation.
      - .3 Strainers in place, baskets clean.
      - .4 Isolating and balancing valves installed, open.
      - .5 Calibrated balancing valves installed, at factory settings.
      - .6 Chemical treatment systems complete, operational.
      - .7 Control valves are properly piped.
      - .8 Coils and radiation are properly piped.
      - .9 BAS in operation.

---

**1.10 APPLICATION TOLERANCES**

- .1 Do TAB to following tolerances of design values:
  - .1 HVAC systems: plus 10%, minus 5%.
  - .2 Hydronic systems: plus or minus 10%.

**1.11 ACCURACY TOLERANCES**

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

**1.12 INSTRUMENTS**

- .1 Prior to TAB, submit to Consultant list of instruments to be used together with serial numbers.
- .2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
- .3 Calibrate within 3 months of TAB. Provide certificate of calibration to Consultant.

**1.13 SUBMITTALS**

- .1 Submit, prior to commencement of TAB:
  - .1 Proposed methodology and procedures for performing TAB if different from referenced standard.

**1.14 PRELIMINARY TAB REPORT**

- .1 Submit for checking and approval of Consultant, prior to submission of formal TAB report, sample of rough TAB sheets. Include:
  - .1 Details of instruments used.
  - .2 Details of TAB procedures employed.
  - .3 Calculations procedures.
  - .4 Summaries.

**1.15 TAB REPORT**

- .1 Format to be in accordance with NEBB, AABC, or SMACNA.
- .2 The following additional information shall be provided for all air systems:
  - .1 Minimum damper position (MAD/Economizer) and the corresponding BAS signal and the voltage to the actuator to meet the full ASHRAE occupied ventilation requirements.
  - .2 Minimum damper position (MAD/Economizer) and the corresponding BAS signal and the voltage to the actuator to meet the full ASHRAE unoccupied ventilation requirements.

- .3 Static pressure reading for each HVAC/AHU unit with VAV/VVT boxes open to 80% of design airflow and bypass damper closed to 0%. Provide reading at normal MAD/economizer damper position, dampers fully closed and dampers fully open.

- .3 TAB report to show all results in SI or imperial units as indicated on plans and to include:
  - .1 Project as-built drawings.
  - .2 System schematics.

#### **1.16 VERIFICATION**

- .1 All reported results subject to verification by Consultant.
- .2 Provide manpower and instrumentation to verify up to 30% of all reported results.
- .3 Number and location of verified results to be at discretion of Consultant.
- .4 Bear costs to repeat TAB as required to satisfaction of Consultant.

#### **1.17 SETTINGS**

- .1 After TAB is completed to satisfaction of Consultant, replace drive guards, close all access doors, lock all devices in set positions, ensure sensors are at required settings. Replace all ceiling tile etc.
- .2 Permanently mark all settings to allow restoration at any time during life of facility. Markings not to be eradicated or covered in any way.

#### **1.18 COMPLETION OF TAB**

- .1 TAB to be considered complete only when final TAB Report received and approved by Consultant.

#### **1.19 AIR SYSTEMS**

- .1 Standard: TAB to be to most stringent of TAB standards of NEBB, AABC, SMACNA, ASHRAE.
- .2 Do TAB of all systems, equipment, components, controls specified in the Mechanical Division including but not limited to following:
  - .1 Air handling systems and equipment
  - .2 Duct testing to SMACNA standards.
- .3 Qualifications: personnel performing TAB to be current member in good standing of NEBB.
- .4 Quality assurance: Perform TAB under direction of qualified supervisor.
- .5 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.

- .6 Locations of equipment measurements: To include, but not be limited to, following as appropriate:
  - .1 Inlet and outlet of each damper, filter, coil, humidifier, fan, and other equipment causing changes in conditions.
  - .2 At each controller, controlled device.
- .7 Locations of systems measurements to include, but not be limited to, following as appropriate: Each main duct, main branch, sub-branch, grille, register or diffuser.

#### **1.20 HYDRONIC SYSTEMS**

- .1 Definitions: for purposes of this section, to include low pressure hot water heating, chilled water, condenser water, glycol systems.
- .2 Standard: TAB to be the most stringent of TAB standards of NEBB, AABC, SMACNA, ASHRAE.
- .3 Do TAB of all systems, equipment, components, controls specified in Mechanical Division including but not limited to hydronic equipment testing.
- .4 Qualifications: personnel performing TAB to be current member in good standing of NEBB.
- .5 Quality assurance: perform TAB under direction of qualified supervisor.
- .6 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: Flow rate, static pressure, pressure drop (or loss), temperature, specific gravity, density, RPM, electrical power voltage, noise, vibration.
- .7 Locations of equipment measurement: To include, but not be limited to, following as appropriate:
  - .1 Inlet and outlet of each heat exchanger (primary and secondary sides), boiler, chiller, coil, humidifier, cooling tower, condenser, pump, PRV, control valve, other equipment causing changes in conditions.
  - .2 At each controller, controlled device.
- .8 Locations of systems measurements to include, but not be limited to, following as appropriate: Supply and return of each primary and secondary loop (main, main branch, branch, sub-branch of all hydronic systems, inlet connection of make-up water.

#### **1.21 DUCT LEAKAGE TESTING**

- .1 Co-ordinate leakage testing with the sheet metal contractor. TAB contractor will be responsible for all duct testing.
- .2 Duct to be tested in accordance with SMACNA HVAC Duct Leakage Test Manual and as indicated.

---

**1.22 DOMESTIC HWC SYSTEMS**

- .1 Meet all requirements as specified for hydronic systems.
- .2 Locations of equipment measurements: To include, but not be limited to, following as appropriate: Inlet and outlet of each heater, tank, pump, circulator, at each controller, controlled device.
- .3 Locations of systems measurements to include, but not be limited to, following as appropriate: main, main branch, branch, sub-branch.

**1.23 OTHER PLUMBING SYSTEMS**

- .1 This contractor shall test, adjust, and record the domestic water (in 1.24 change read “plumbing”) system after the plumbing contractor has completed their work.
  - .1 Pressure booster systems: test for capacity and pressures under all conditions and at all times.
- .2 This contractor shall test, adjust, and record the domestic water (in 1.24 change read “plumbing”) system after the plumbing contractor has completed their work.
  - .1 Recirculating Systems: pump flows and pressures
  - .2 Pumped sanitary and storm water systems: test for proper operation at all possible flow rates.

**1.24 OTHER TAB REQUIREMENTS**

- .1 General requirements applicable to all work specified this paragraph:
  - .1 Qualifications of TAB personnel: as for air systems specified this section.
- .2 Quality assurance: as for air systems specified this section.
- .3 Building pressure conditions:
  - .1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions at all times.
  - .2 TAB procedures:

<u>Positive</u>	<u>Negative</u>
Corridors	Washrooms
- .4 Zone pressure differences:
  - .1 Adjust HVAC systems, equipment, controls to establish air pressure differentials, with all systems in all possible combinations of normal operating modes.
- .5 Provide duct testing as specified.
- .6 Provide AHU testing as specified.
- .7 Provide plenum testing as specified.



- .8 Changing of air handling equipment sheave and belts as required for specified air flow sheaves and belts supplied by unit manufacturer. Retest equipment after sheave change.

**END OF SECTION**

**Part 1            General**

**1.1            GENERAL**

- .1      The Mechanical Contractor shall provide the labour and material to conduct the closeout process as outlined in this specification section.
- .2      The mechanical contractor shall perform the closeout requirements specified in conjunction with the independent commissioning consultant (CC) retained by the owner.

**Part 2            Products**

**2.1            GENERAL**

- .1      The mechanical contractor and manufacturers shall provide all instrumentation and equipment necessary to conduct the tests specified. The Mechanical Contractor shall advise the Mechanical Consultant of instrumentation to be used and the dates the instruments were calibrated.

**Part 3            Execution**

**3.1            THE CONTRACT CLOSE OUT PROCESS**

- .1      The mechanical contractor close out process shall consist of:
  - Shop Drawings and As-built Drawings
  - Installation inspection and equipment verification
  - Plumbing and drainage system testing
  - Testing of piping systems
  - Independent contractor balancing of water systems
  - Testing of air systems
  - Independent contractor balancing of air systems
  - Testing of equipment and systems
  - BAS Commissioning
  - Verification of refrigeration leak detection systems
  - Commissioning meetings
  - Operating and maintenance manuals
  - Training
  - Systems Demonstration and turnover
  - Testing forms
  - Warranties
  - Contractor to provide list of equipment maintenance including schedule of maintenance parts, quantities, and model fixtures, etc.

**3.2 SHOP DRAWINGS AND AS-BUILT DRAWINGS**

- .1 Conform to General Requirements Section for shop drawings and as-built drawings requirements.

**3.3 INSTALLATION INSPECTION AND EQUIPMENT VERIFICATION**

- .1 The Mechanical Contractor shall co-ordinate with the Consultant who will inspect the mechanical installation.
- .2 The Mechanical Contractor shall complete the equipment verification forms for each piece of equipment. The forms shall be included in the operating and maintenance manual. The equipment data shall include:
  - Manufacturers name, address and telephone number
  - Distributors name, address and telephone number
  - Make, model number and serial number
  - Pumps - RPM, impeller sizes, rated flow
  - Fans - belt type and size, shive type and size
  - Electrical - volts, amps, fuse size, overload size
  - Any other special characteristics.

**3.4 THE CONTRACTOR'S TESTING OF PIPING SYSTEMS**

- .1 Test all piping systems in accordance with all applicable plumbing codes and General Requirements section.
- .2 All tests for the systems shall be performed in the presence of the Consultant or Commissioning Consultant. Complete the testing forms and forward to the Consultant.

**3.5 THE INDEPENDENT CONTRACTORS TESTING AND BALANCING OF WATER SYSTEMS**

- .1 Conform with the specification section, Testing, Adjusting and Balancing.
- .2 The Independent Contractor shall be hired by The Mechanical Contractor and shall report to the Commissioning Consultant.

**3.6 THE CONTRACTORS TESTING OF AIR SYSTEMS**

- .1 Conform with the specification section, Testing, Adjusting and Balancing.
- .2 All tests shall be performed in the presence of the Mechanical Consultant or the Commissioning Consultant. Complete the testing forms and forward to the Consultant.

**3.7 THE INDEPENDENT CONTRACTORS TESTING AND BALANCING OF AIR SYSTEMS**

- .1 Conform with specification section, Testing, Adjusting and Balancing.
- .2 The Independent Contractor shall be hired by The Mechanical Contractor and shall report to the Commissioning Consultant.

### **3.8 TESTING OF EQUIPMENT AND SYSTEMS**

- .1 General:
  - .1 The Mechanical Contractor shall hire the services of the manufacturers technicians to test the equipment and associated systems. The technician shall record the results of the tests on the testing forms. The tests shall be witnessed by the Consultant or Owners representative. When the tests have been completed satisfactorily the technician and witnessing authority shall sign the forms. A copy of the forms shall be forwarded to the Consultant. The original shall be inserted into the operating and maintenance manual.
  - .2 Should equipment or systems fail a test, the test shall be repeated after repairs or adjustments have been made. The additional tests shall be witnessed.
  - .3 Tests which have not been witnessed shall not be accepted and shall be repeated.
  - .4 The equipment and systems to be tested shall include:
    - Boilers and Pumps
    - Air Handling Units
    - Life Safety and Fire Protection Systems
    - Water Treatment Systems
    - Building Automation Systems (BAS)
- .2 BAS Testing:
  - .1 The BAS Contractor shall test the system as described in General Requirements and/or Controls Sections.
  - .2 Co-ordinate with the Consultant and submit completed test forms monthly.
  - .3 Demonstrate to the Owner and Consultant the operation of the BAS when all tests have been completed.
- .3 Verification of Refrigeration Leak Detection System Operation:
  - .1 The commissioning process shall include the verification of the refrigeration leak detection system.
  - .2 All interlocks between leak detection systems installed and system components, as well as interlocks between field installed detection systems and associated safety system components shall be tested and verified to operate as per the requirements of CSA B52. Specifically, the following shall occur for each independent system on registration of a refrigerant leak:
    - .1 Open all zone dampers in the affected system.
    - .2 Disable all electric reheat coils within the affected system.
    - .3 Activate field installed safety shut off valves within the affected refrigeration system.
    - .4 Energize all fans within the affected ductwork system.
    - .5 Activate all refrigerant leak system specific ventilation systems.
    - .6 De-energize any other potential sources of ignition within the affected system.

### **3.9 CLOSEOUT SCHEDULE**

- .1 The Mechanical Contractor shall include the schedule for all tests and equipment start-up tests in the construction schedule.
- .2 All testing forms and reports associated with the mechanical systems shall be directed to the Consultant with copies to the Owner and Consultant.
- .3 The forms and reports to be issued shall include:
  - Shop drawings, issued and accepted
  - Equipment verification forms
  - Testing forms
  - Reports resulting from tests
  - Testing schedule
  - Equipment Start-up Forms

### **3.10 OPERATION AND MAINTENANCE MANUAL**

- .1 Conform to General Requirements section for the Operating and Maintenance Manual requirements.

### **3.11 OPERATOR TRAINING**

- .1 Conform to General Requirements section for requirements for Instruction to Operating Staff.
- .2 The training shall be conducted in a classroom and at the equipment or system.
- .3 Training will begin when the operating and maintenance manuals have been delivered to The Owner and approved by the Consultant.
- .4 Each training session shall be structured to cover:

The operating and maintenance manual

  - Operating procedures
  - Maintenance procedures
  - Trouble-shooting procedures
  - Spare parts required
  - Submit a course outline to the Mechanical Consultant before training commences.

Provide course documentation for up to eight people.
- .5 The training sessions shall be scheduled and co-ordinated by the Mechanical Contractor.
- .6 Training shall be provided for the following systems:

<u>System</u>	<u>Minimum Training Times</u>
Air Handling Units	2 hours
The Mechanical System	8 hours
Boilers	½ hour
Life Safety & Fire Protection	½ hour

- .7 The minimum training for the BAS shall be 16 hours. The training shall include:
- A walk through of the installation for the Building Owner to review the installation and equipment
  - Operation of the central computer
  - Operation of portable terminals
  - Control sequences
  - Report set-up and generation
  - Managing the system
  - Maintenance requirements
- Refer to Controls specification section for further information.
- .8 The training requirement for the mechanical system shall include a walk-through of the building by the Mechanical Contractor. During the walk through the Mechanical Contractor shall:
- Identify equipment
  - Identify starters associated with equipment
  - Identify valves and balancing dampers
  - Identify access doors
  - Review general maintenance of equipment
  - Review drain points in pipework systems
  - Identify maintenance items
- .9 When each training session has been completed The Owner shall sign the associated form to verify completion.

### **3.12 COMMISSIONING CONSULTANT**

- .1 A Commissioning Consultant (CC) reports to the Owner.
- .2 The CC responsibilities shall include:
- preparing the commissioning plan
  - co-ordinating with the contractor to schedule tests
  - preparing a test form manual
  - witnessing selected tests
  - receiving all test forms
  - conducting performance test
  - co-ordinating the contractors training
  - chair commissioning meetings
- .3 The Mechanical Contractor shall co-operate with the CC.
- .4 The Mechanical Contractor shall provide assistance to the CC and have personnel available during the performance testing procedure. Each mechanical system shall be tested in the operational mode.
- .5 Performance testing shall begin when all systems have been completed, tested by the Mechanical Contractor and the Consultant has completed their final review.

**3.13 MECHANICAL SYSTEM DEMONSTRATION AND TURNOVER**

- .1 Refer to General Requirements section, Mechanical Project Completion.
- .2 The system demonstration and turnover to The Owner shall occur when:
  - The installation is complete
  - The acceptance test conducted by the Mechanical Consultant has been completed successfully
  - The Commissioning Consultant system performance testing has been completed successfully
  - Training has been completed
  - Operating and Maintenance Manuals have been accepted
  - Shop-drawings have been updated
  - As-built drawings have been completed
- .3 The systems demonstration shall be conducted by the Mechanical Contractor and the manufacturers. The demonstration shall cover a demonstration of equipment installation and operation.

**3.14 TESTING FORMS**

- .1 The Mechanical Contractor and manufacturers shall provide forms for testing. The forms must be approved by the Consultant and The Owner before they are used.

**3.15 WARRANTIES**

- .1 Equipment and system warranties shall not begin until the system demonstration and turnover has been conducted successfully and accepted by The Owner.
- .2 The Mechanical Contractor shall fill out the warranty form listing the equipment and systems and the start and finishing dates for warranty.
- .3 Refer to the general conditions specification section for the requirements during the warranty period.

**3.16 CLOSEOUT PROCESS ALLOCATION**

- .1 The Mechanical Contractor shall submit all test and verification forms. The Consultant will use these forms to calculate percentage complete.
- .2 Total completion shall not be granted out until the performance testing, O & M manuals, systems demonstration, and training including all required paperwork have been completed to the satisfaction of the consultant. Refer to General Requirements section for contract breakdown.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 Canadian General Standards Board (CGSB)
  - .1 CGSB 51-GP-52Ma-[89], Vapour Barrier Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .3 Underwriters Laboratories of Canada (ULC).
  - .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
- .4 American Society for Testing and Materials (ASTM).
  - .1 ASTM C177 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Mean of the Guarded Hot-Plate Apparatus.
  - .2 ASTM C518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
  - .3 ASTM C 449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
  - .4 ASTM C1729 Standard Specification for Aluminum Jacketing for Insulation.
  - .5 ASTM C1290 Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
  - .6 ASTM C1393 Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes And Tanks.
  - .7 ASTM C553, Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
  - .8 ASTM C612, Mineral Fiber Block and Board Thermal Insulation.
  - .9 ASTM C 411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
  - .10 ASTM C 795, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
  - .11 ASTM C 921, Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .5 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).
  - .1 ASHRAE Standard 90.1.
- .6 Manufacturer's Trade Associations.
  - .1 Thermal Insulation Association of Canada (TIAC)
  - .2 North American Commercial and Industrial Insulation Standards.



## **1.2 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with general requirements.
- .2 Submit for approval manufacturer's catalogue literature related to installation, fabrication for duct jointing recommendations.
- .3 Submit completed detail plates from the North American Commercial and Industrial Insulation Standards manual, applicable to installation types required by this specification section.

## **1.3 INSTALLATION INSTRUCTIONS**

- .1 Submit manufacturer's installation instructions in accordance with general requirements.
- .2 Installation instructions to include procedures to be used, installation standards to be achieved.

## **1.4 QUALIFICATIONS**

- .1 Installer to have successfully completed apprenticeship program.
- .2 Installer to be specialist in performing work of this section and have at least 3 years successful experience in this size and type of project, qualified to standards of TIAC.

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

- .1 Deliver materials to site in original factory packaging, labeled with manufacturer's name, address.
- .2 Protect from weather and construction traffic.
- .3 Protect against damage from any source.
- .4 Store at temperatures and conditions required by manufacturer.

## **1.6 DEFINITIONS**

- .1 For purposes of this section:
  - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
  - .2 "EXPOSED" - will mean "not concealed" as defined herein.
  - .3 "ASJ+" – All Service Jacket – vapor retarder laminate of aluminium foil inner layer, reinforced with fiberglass scrim, bonded to a bleached kraft paper, with outer poly film leaving no paper exposed.
  - .4 "ASJ" – All Service Jacket (no outer film) – vapor retarder laminate of aluminium foil inner layer, reinforced with fiberglass scrim, bonded to a bleached kraft paper outer layer.
  - .5 "FSK" – Foil Scrim Kraft – vapor retarder laminate of aluminium foil outer layer, reinforced with fiberglass scrim, bonded to a natural kraft paper inner layer.
- .2 Insulation systems - insulation material, fasteners, jackets, and other accessories.

## **1.7 QUALITY ASSURANCE**

- .1 Products shall not contain formaldehyde, asbestos, lead, mercury or mercury compounds or PBDE fire retardants.
- .2 **Products shall be Certified UL GREENGUARD Gold or Indoor Advantage Gold and formaldehyde free.**
- .3 **Recycled content: Mineral fiber products will contain a minimum of 50% recycled glass content certified and UL validated, and are to be constructed using bio-based thermosetting binder.**

## **Part 2 Products**

### **2.1 LIMITATION ON MATERIALS**

- .1 Products shall not contain formaldehyde, asbestos, lead, mercury or mercury compounds or PBDE fire retardants.
- .2 Materials shall be: **“Certified Asthma and allergy friendly” and “verified Healthy Air.”**

### **2.2 FIRE AND SMOKE RATING**

- .1 In accordance with CAN/ULC S102:
  - .1 Maximum flame spread rating: 25.
  - .2 Maximum smoke developed rating: 50.

### **2.3 INSULATION**

- .1 Mineral fibre as specified herein includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C (75°F) mean temperature when tested in accordance with ASTM C177 or ASTM C518.
- .3 Type C-1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket meeting the requirement of ASTM C1136 Type II and IV (FSK):
  - .1 Jacket: to ASTM C1136 Type II and IV (FSK)
  - .2 Maximum "k" value: .033 W/M•°C (.23 BTU•IN/HR•FT²•°F)
- .4 Type C-2: Mineral fibre blanket to ASTM C553 Type I, II, and III, ASTM C1136 Type II and IV, and ASTM C1290 Type III:
  - .1 Jacket: to ASTM C1136, Type II and IV.
  - .2 Maximum "k" value: 0.042 W/M•°C (.29 BTU•IN/HR•FT²•°F)
- .5 Type C-3: High temperature fire rated duct wrap, ULC classified soluble amorphous wool blanket with factory applied flame resistant aluminum foil fiberglass reinforced facing. Suitable for up to 1200°F service temperature.
  - .1 Acceptable Materials:
    - 3M
    - Morgan Firemaster Fastwrap XL
    - CL4 Fire

- .6 Manufacturers:
  - .1 All materials must be supplied by the same manufacturer.
  - .2 Acceptable Materials:
    - .1 Johns Manville **(with proof of Asthma and allergy friendly certification)**
    - .2 Knauf
    - .3 Manson

## 2.4 JACKETS

- .1 Canvas:
  - .1 220 g/m<sup>2</sup> (6 oz/sq.yd.) cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.
  - .2 Lagging adhesive: Compatible with insulation.
- .2 Aluminum:
  - .1 To ASTM C1729 with moisture barrier as scheduled in PART 3 of this section.
  - .2 Thickness: 0.5 mm (0.020") sheet.
  - .3 Finish: Smooth.
  - .4 Jacket banding and mechanical seals: 15 mm (1/2") wide, 0.5 mm (0.020") thick stainless steel.
  - .5 Provide exterior silicone sealant on all joints.
  - .6 **Self-adhesive aluminum jackets are not permitted.**

## 2.5 ACCESSORIES

- .1 Vapour retarder lap adhesive:
  - .1 Water based, fire retardant type, compatible with insulation.
- .2 Indoor Vapour Retarder Finish:
  - .1 Compatible with insulation.
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C 449.
- .4 ULC Listed Canvas Jacket:
  - .1 220 g/m<sup>2</sup> (6oz/yd<sup>2</sup>) cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.
- .5 Tape: self-adhesive, aluminum, reinforced, 75 mm (3") wide minimum.
- .6 Contact adhesive: quick-setting Childers CP-82 or equal.
- .7 Canvas adhesive: washable.
- .8 Tie wire: 1.5 mm (16 gauge) stainless steel.
- .9 Facing: 25 mm (1") stainless steel hexagonal wire mesh stitched on one face of insulation
- .10 Fasteners: weld pins, length to suit insulation, with 40 mm (1½") diameter clips.

- .11 **Outdoor Vapour Retarder Mastic:**
  - .1 **Reinforcing fabric: Open weave fibreglass fabric, with maximum weave of 10x10 squares per inch.**
- .12 **Banding: 15 mm (1/2") wide, 0.5 mm (26 gauge) thick stainless steel.**

### Part 3 Execution

#### 3.1 PRE-INSTALLATION REQUIREMENTS

- .1 Pressure testing of ductwork systems to be complete, witnessed, and certified.
- .2 Surfaces to be clean, dry, free from foreign material.

#### 3.2 INSTALLATION

- .1 Install in accordance with North American Commercial and Industrial Insulation Standards.
- .2 Apply materials in accordance with manufacturers instructions and this specification.
- .3 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1 Hangers, supports to be outside vapour retarder jacket.
- .4 Supports, Hangers in accordance with general requirements.
  - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .5 Fasteners: At 300 mm (12") oc. in horizontal and vertical directions, minimum two rows each side.
- .6 Provide rigid insulation for exposed ductwork.
- .7 **Use two layers with staggered joints when required nominal thickness exceeds 75 mm (3").**

#### 3.3 DUCTWORK INSULATION SCHEDULE

- .1 Insulation types and thicknesses conform to following table:

Application	Type	Thickness
Rectangular supply air ducts	C-1	25 mm (1")
Round supply air ducts	C-2	25 mm (1")
Supply, return and fan exhaust ducts exposed (visible) in space being served	none	
Outdoor air intake ductwork and plenums	C-1	50 mm (2")
Exhaust plenums dampers and louvres	C-1	25 mm (1")
Interior acoustically lined ducts	none	
<b>Breeching</b>	<b>C-3</b>	<b>50 mm (2")</b>
Last 1.5m of Exhaust duct	C-1	25 mm (1")
Indoor relief air ducts	C-1	25 mm (1")
Exterior ductwork	C-1	80 mm (3")

- .2 Exposed round ducts 600 mm (24") and larger, smaller sizes where subject to abuse:
  - .1 Use TIAC code C-1 insulation, scored to suit diameter of duct.
  - .2 C-6 insulation is also acceptable. Same thickness, schedule, and facing to be used as C-1 material.**
- .3 Finishes: Conform to following table:

Application	Rectangular	Round
Indoor, concealed	none	none
Indoor, exposed	Canvas	Canvas
Outdoor, exposed to Precipitation	Aluminum	Aluminum
Breeching	Canvas	Canvas

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 Canadian General Standards Board (CGSB)
  - .1 ASTM C553, Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
  - .2 CAN/ULC-S702, Mineral Fiber Thermal Insulation for Buildings.
  - .3 ASTM C612, Mineral Fiber Block and Board Thermal Insulation.
  - .4 CGSB 51-GP-52Ma, Vapour Barrier Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .3 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
- .4 American Society for Testing and Materials (ASTM)
  - .1 ASTM C1729 Standard Specification for Aluminium Jacketing for Insulation.
  - .2 ASTM C1393 Standard Specification for Perpendicularly Oriented Mineral Fibre Roll and Sheet Thermal Insulation for Pipes and Tanks.
  - .3 ASTM C534 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
  - .4 ASTM C533 Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
  - .5 ASTM C177 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
  - .6 ASTM C518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
  - .7 ASTM C411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
  - .8 ASTM C449, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
  - .9 ASTM C795, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
  - .10 ASTM C921, Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .5 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
  - .1 ASHRAE Standard 90.1.
- .6 Manufacturer's Trade Associations
  - .1 Thermal Insulation Association of Canada (TIAC)

- .2 North American Commercial and Industrial Insulation Standards.

## **1.2 PRODUCT DATA**

- .1 Submit Product Data in accordance general requirements.

## **1.3 SAMPLES SUBMITTALS**

- .1 Submit samples in accordance with general requirements.
- .2 Submit for approval: completed detail plate assemblies of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 15 mm (1/2") plywood board. Affix typewritten label beneath sample indicating service.

## **1.4 INSTALLATION INSTRUCTIONS**

- .1 Submit properly completed detail plates from the North American Commercial and Industrial Insulation Standards manual, applicable to installation types required by this specification section.
- .2 Submit manufacturer's installation instructions in accordance with general requirements.
- .3 Installation instructions to include procedures to be used, installation standards to be achieved.

## **1.5 QUALIFICATIONS**

- .1 Installer to have successfully completed apprenticeship program.
- .2 Installer to be specialist in performing work of this section and have at least three (3) years successful experience in this size and type of project, qualified to standards of TIAC.

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

- .1 Deliver materials to site in original factory packaging, labeled with manufacturer's name, address.
- .2 Protect from weather and construction traffic.
- .3 Protect against damage from any source.
- .4 Store at temperatures and conditions required by manufacturer.

## **1.7 DEFINITIONS**

- .1 For purposes of this section:
  - .1 "CONCEALED" – insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
  - .2 "EXPOSED" – will mean "not concealed" as defined herein.
  - .3 "Insulation Systems" – insulation material, fasteners, jackets, and other accessories.

- .4 "ASJ+" All Service Jacket – vapor retarded laminate of aluminium foil inner layer reinforced with fibreglass scrim, bonded to a bleached kraft paper with outer poly film layer leaving no paper exposed.
- .5 "ASJ" All Service Jacket – (no outer film) vapor retarder laminate of aluminum foil inner layer reinforced with fibreglass scrim, bonded to a bleached kraft paper outer layer.
- .6 "FSK" Foil Scrim Kraft – vapor retarder laminate of aluminium foil outer layer, reinforced with fibreglass scrim, bonded to a natural kraft paper inner layer.
- .7 "PSK" Poly Scrim Kraft – vapor retarder laminate of polypropylene outer layer, reinforced with fibreglass scrim, bonded to a natural kraft paper inner layer.
- .8 "PVC" Poly Vinyl Chloride – polymer to manufacture non-metallic final protective finish jacket over insulation systems.

## **Part 2 Products**

### **2.1 LIMITATION ON MATERIALS**

- .1 Product shall not contain formaldehyde, asbestos, lead, mercury, or mercury compounds, or PBDE fire retardants.

### **2.2 FIRE AND SMOKE RATING**

- .1 In accordance with CAN/ULC S102:
  - .1 Maximum flame spread rating: 25.
  - .2 Maximum smoke developed rating: 50.

### **2.3 INSULATION**

- .1 Mineral fibre as specified herein includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C (75°F) mean temperature when tested in accordance with ASTM C177 or ASTM C518.
- .3 Type A-1: Fibre glass pipe and tank insulation
  - .1 Segmented, flexible fiberglass board bonded to laminated vapor retarder, ASJ or FSK.
  - .2 Complying with ASTM C1393, Type II or Type III Category 2.
  - .3 Maximum "k" value: 0.037W/M (or less) x C°@100°F (38°C) is 0.26BTU x IN/H FT² x °F
  - .4 Jacket: specified in 'Factory-Applied Jackets' Article

### **2.4 CEMENT**

- .1 Hydraulic setting cement
  - .1 To ASTM C449
- .2 Air setting cement
  - .1 To ASTM C195



- .3 Hydraulic setting cement shall be used for all finishing work and areas where equipment is not concealed.

## **2.5 JACKETS**

- .1 Canvas:
  - .1 220 g/m<sup>2</sup> (6 oz/sq yd) cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
  - .2 Lagging adhesive: Compatible with insulation.

## **2.6 INSULATION SECUREMENTS**

- .1 Tape: Self-adhesive, aluminum, [reinforced], 50 mm (2") wide minimum.
- .2 Contact adhesive: Quick setting.
- .3 Canvas adhesive: Washable.
- .4 Tie wire: 1.5 mm (16 gauge) diameter stainless steel.
- .5 Bands: Stainless steel, 20 mm (3/4") wide, 0.5 mm (26 gauge) thick.
- .6 Facing: 25 mm (1") galvanized steel hexagonal wire mesh on one face of insulation.
- .7 Fasteners: 4 mm (5/32") diameter pins with 40 mm (1½") clips. Length of pin to suit thickness of insulation. Pins to be CD weld, self-adhesive or glue applied – to be selected and confirmed with consultant in accordance with required service conditions.

## **2.7 VAPOUR RETARDER LAP ADHESIVE**

- .1 Water based, fire retardant type, compatible with insulation.

## **2.8 INDOOR VAPOUR RETARDER FINISH**

- .1 Compatible with insulation.

## **2.9 OUTDOOR VAPOUR RETARDER MASTIC**

- .1 Compatible with insulation.
- .2 Reinforcing fabric: Open weave fibreglass fabric with a maximum weave of 10 x 10 squares per inch.

## **Part 3 Execution**

### **3.1 PRE-INSTALLATION REQUIREMENTS**

- .1 Pressure testing of equipment and adjacent piping systems to be complete, witnessed, and certified.
- .2 Surfaces to be clean, dry, free from foreign material.

### 3.2 INSTALLATION

- .1 Install in accordance with TIAC and North American Commercial and Industrial Insulation Standards.
  - .1 Hot equipment: To TIAC code 1503-H.
  - .2 Cold equipment: to TIAC code 1503-C.
- .2 Provide a completely insulated system allowing for insulation over all valves, fittings, air separators, pumps, buffer tanks, and other connected equipment to the system.
- .3 Elastomeric Insulation: to remain dry at all times. Overlaps to be to manufacturer instructions. Joints to be tight and sealed properly.
- .4 Provide vapour retarder as recommended by manufacturer.
- .5 Apply materials in accordance with insulation and equipment manufacturers instructions and this specification.
- .6 Below ambient/chilled water installation:
  - .1 All pipes, fittings, valves, strainers, flanges, unions, and other pipe system components and specialties must be properly insulated with correctly completed vapor retarded applied.
  - .2 All insulation material must have properly installed and sealed vapor retarding jacket, including circumferential and longitudinal seams.
  - .3 All penetrations, tears, and punctures must be repaired and sealed with a vapor retarding material with a .02 or lower perm rating.
  - .4 Vapor stops must be installed at 18' intervals, at all pipe insulation termination points, including fittings, flanges, and other changes in direction or other types of piping specialties.
  - .5 All fitting insulation must be of the same type, thickness, and density of the pipe insulation, be premoulded insulation covers or fabricated from the same material as the pipe insulation. Full thickness must be factory-applied, vapor-retarder facing is unacceptable.
  - .6 A complete vapor retarder must be installed on insulation over fittings before applying final finish. Vapor retarder must extend onto and be sealed to the vapor retarder or pipe insulation.
  - .7 Additional fitting covers, PVC or metal, must have a vapor retarder seal applied to all longitudinal and circumferential seams in addition to the vapor retarder applied to the fitting insulation.
  - .8 Additional field applied jackets must not use staples, screws, tacks or rivets for attachment, to avoid puncturing vapor retarder underneath.
  - .9 Insulating support inserts are to be high compressive strength insulation with a rigid shield. No calcium silicate is to be used for insulation on below-ambient operation piping.
- .7 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm (3").

- .8 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1 Hangers, supports to be outside vapour retarder jacket.
- .9 Supports, Hangers:
  - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

### 3.3 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

- .1 Flexible removable blanket insulation covers are not acceptable for below ambient (cold) operating piping systems. Rigid removable insulation jackets of the vapor retarder exterior material that can be vapor sealed at the seams, are acceptable on below ambient (cold) operation piping systems.
- .2 Application: At expansion joints, valves, primary flow measuring elements flanges and unions at equipment.
- .3 Installation to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation. Fabricate flexible, removable insulation in accordance with ASTM C 1695, Standard Specification for fabrication of flexible removable and reusable blanket insulation for hot service.

### 3.4 EQUIPMENT INSULATION SCHEDULES

- .1 Includes valves, valve bonnets, strainers, flanges, air separators, and fittings unless otherwise specified.
- .2 Hot Equipment:
  - .1 Type and Thickness:

ITEM	THICKNESS	TYPE
Hot water heating tanks	25 mm (1")	A1
<b>Hot Water Pumps</b>	<b>25 mm (1")</b>	<b>A1</b>
- .3 Finishes:
  - .1 Equipment in mechanical rooms: TIAC code CEF/1 with canvas jacket.
  - .2 Equipment elsewhere: TIAC code CEF/2 with canvas jackets.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-51.53, Poly (Vinyl Chloride) Jacketing Sheet, for Insulating Pipes, Vessels, and Round Ducts.
- .3 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC-S102, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
- .4 American Society for Testing and Materials (ASTM)
  - .1 ASTM C547, Type I and IV Standard Specification for Mineral Fiber Pipe Insulation.
  - .2 ASTM C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
  - .3 ASTM C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus to recognize the correct thermal insulation performance testing for blanket.
  - .4 ASTM C1393, Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks
  - .5 ASTM C1695, Standard Specification for Fabrication of Flexible Removable and Reusable Blanket Insulation for Hot Service.
  - .6 ASTM C 335, Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
  - .7 ASTM C 921, Practice for Determining the Properties Jacketing Materials for Thermal Insulation.
  - .8 ASTM C1729 Standard Specification for Aluminium Jacketing for Insulation.
  - .9 ASTM C553, Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
  - .10 CGSB 51-GP-52Ma, Vapour Barrier Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .5 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).
  - .1 ASHRAE Standard 90.1.
- .6 Manufacturer's Trade Associations
  - .1 Thermal Insulation Association of Canada (TIAC)
  - .2 North American Commercial and Industrial Insulation Standards

## **1.2 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with general requirements.
- .2 Submit properly completed detail plates from the North American Commercial and Industrial Insulation Standards manual, applicable to installation types required by this specific section.
- .3 Submit for approval manufacturer's catalogue literature related to installation, fabrication for pipe, fittings, valves, and jointing recommendations.

## **1.3 INSTALLATION INSTRUCTIONS**

- .1 Submit manufacturer's installation instructions in accordance with general requirements.
- .2 Installation instructions to include procedures to be used, installation standards to be achieved.

## **1.4 QUALIFICATIONS**

- .1 Installer to have successfully completed apprenticeship program.
- .2 Installer to be specialist in performing work of this section and have at least 3 years successful experience in this size and type of project, qualified to standards of TIAC.

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

- .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Protect from weather, construction traffic.
- .3 Protect against damage from any source.
- .4 Store at temperatures and conditions required by manufacturer.

## **1.6 DEFINITIONS**

- .1 For purposes of this section:
  - .1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
  - .2 "EXPOSED" - will mean "not concealed" as defined herein.
  - .3 "ASJ+" – All Service Jacket – vapor retarder laminate of aluminium foil inner layer, reinforced with fiberglass scrim, bonded to a bleached kraft paper, with outer poly film leaving no paper exposed.
  - .4 "ASJ" – All Service Jacket (no outer film) – vapor retarder laminate of aluminium foil inner layer, reinforced with fiberglass scrim, bonded to a bleached kraft paper outer layer.
  - .5 "FSK" – Foil Scrim Kraft – vapor retarder laminate of aluminum foil outer layer, reinforced with fiberglass scrim, bonded to a natural kraft paper inner liner.
  - .6 "PSK" – Poly Scrim Kraft – vapor retarder laminate of polypropylene outer layer, reinforced with fiberglass scrim, bonded to a natural kraft paper inner layer.

- .7 “PVC” – Poly Vinyl Chloride – polymer used to manufacture a non-metallic final protective finish jacket over insulation systems.

## **1.7 QUALITY ASSURANCE**

- .1 Products shall not contain formaldehyde, asbestos, lead, mercury or mercury compounds or PBDE fire retardants.
- .2 **Products shall be Certified UL GREENGUARD Gold or Indoor Advantage Gold and formaldehyde free.**
- .3 **Recycled content: Mineral fiber products will contain a minimum of 50% recycled glass content certified and UL validated and are to be constructed using bio-based thermosetting binder.**

## **Part 2 Products**

### **2.1 MATERIAL LIMITATIONS**

- .1 Products shall not contain formaldehyde, asbestos, lead, mercury or mercury compounds or PBDE fire retardants.

### **2.2 FIRE AND SMOKE RATING**

- .1 In accordance with CAN/ULC-S102:
  - .1 Maximum flame spread rating: 25.
  - .2 Maximum smoke developed rating: 50.

### **2.3 INSULATION**

- .1 Mineral fibre as specified herein includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C (75°F) mean temperature when tested in accordance with ASTM C335, ASTM C177 or ASTM C518.
- .3 Type A-1: Rigid moulded or wound mineral fibre with factory applied vapour retarder jacket.
  - .1 Mineral fibre: to ASTM C547 Type I and IV.
  - .2 Jacket: to ASTM C1136, Type I, II, III, IV, X.
  - .3 Maximum "k" factor: to ASTM C547.
- .4 Materials:
  - .1 All materials must be supplied by the same manufacturer.
  - .2 Acceptable Materials:
    - .1 Knauf
    - .2 Manson
    - .3 Owens Corning

## **2.4 INSULATION SECUREMENT**

- .1 Tape: Self-adhesive, aluminum, reinforced, 50 mm (2") wide minimum.
- .2 Contact adhesive: Quick setting.
- .3 Canvas adhesive: Washable.
- .4 **Tie wire: 1.5mm (16 gauge) diameter stainless steel.**
- .5 **Bands: Stainless steel, 20 mm (3/4") wide, 0.5 mm (0.020") thick.**

## **2.5 CEMENT**

- .1 Thermal insulating and finishing cement:
  - .1 Air drying on mineral wool, to ASTM C 449M.
  - .2 Hydraulic setting on mineral wool, to ASTM C165

## **2.6 VAPOUR RETARDER LAP ADHESIVE**

- .1 Water based, fire retardant type, compatible with insulation.

## **2.7 INDOOR VAPOUR RETARDER FINISH**

- .1 Compatible with insulation.

## **2.8 OUTDOOR VAPOUR RETARDER FINISH**

- .1 Compatible with insulation.
- .2 Reinforcing fabric: Open weave fibreglass fabric, with maximum weave of 10 x 10 squares per inch.

## **2.9 JACKETS**

- .1 Polyvinyl Chloride (PVC):
  - .1 Minimum thickness: 20mil (0.020")
  - .2 One-piece moulded type [and sheet] to CAN/CGSB-51.53 with pre-formed shapes as required.
  - .3 Colours: white.
  - .4 Minimum service temperatures: -29°C (-20°F).
  - .5 Maximum service temperature: 65°C (150°F).
  - .6 Moisture vapour transmission: 0.05 perm.
  - .7 Fastenings:
    - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
    - .2 Tacks (not to be used on below-ambient temperature systems)
    - .3 Pressure sensitive vinyl tape of matching colour.
- .2 Canvas:
  - .1 220 g/m<sup>2</sup> (6oz/sq yd) cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.

- .2 Lagging adhesive: Compatible with insulation.

## **2.10 CAULKING FOR JACKETS**

- .1 Caulking: Silicone clear caulking.

## **Part 3 Execution**

### **3.1 PRE-INSTALLATION REQUIREMENT**

- .1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed, and certified.
- .2 Surfaces to be clean, dry, free from foreign material.

### **3.2 INSTALLATION**

- .1 Install in accordance with North American Commercial and Industrial Insulation Standards.
- .2 Provide continuous insulation for complete systems including all valves, air separators, fittings, and other equipment.
- .3 Apply materials in accordance with manufacturers' instructions and this specification.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1 Hangers, supports to be outside vapour retarder jacket.
- .5 Supports, Hangers:
  - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.
- .6 **Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm (3").**
- .7 Below ambient/chilled water installation:
  - .1 All pipes, fittings, valves, strainers, flanges, unions, and other pipe system components and specialties must be properly insulated with correctly completed vapor retarded applied.
  - .2 All insulation material must have properly installed and sealed vapor retarding jacket, including circumferential and longitudinal seams.
  - .3 All penetrations, tears, and punctures must be repaired and sealed with a vapor retarding material with a .02 or lower perm rating.
  - .4 Vapor stops must be installed at 18' intervals, at all pipe insulation termination points, including fittings, flanges, and other changes in direction or other types of piping specialties.
  - .5 All fitting insulation must be of the same type, thickness, and density of the pipe insulation, be premoulded insulation covers or fabricated from the same material as the pipe insulation. Full thickness must be factory-applied, vapor-retarder facing is unacceptable.



- .6 A complete vapor retarder must be installed on insulation over fittings before applying final finish. Vapor retarder must extend onto and be sealed to the vapor retarder or pipe insulation.
- .7 Additional fitting covers, PVC or metal, must have a vapor retarder seal applied to all longitudinal and circumferential seams in addition to the vapor retarder applied to the fitting insulation.
- .8 Additional field applied jackets must not use staples, screws, tacks or rivets for attachment, to avoid puncturing vapor retarder underneath.
- .9 Insulating support inserts are to be high compressive strength insulation with a rigid shield. No calcium silicate is to be used for insulation on below-ambient operation piping.

### 3.3 REMOVABLE, PREFABRICATED, INSULATION AND ENCLOSURES

- .1 Application: At expansion joints, valves, primary flow measuring elements, flanges, and unions at equipment.
- .2 Flexible removable insulation covers are not acceptable for below-ambient (cold) operation piping systems. Rigid removable insulation jackets that are vapor retarder exterior material that can be vapor sealed at the seams, are acceptable on below-ambient (cold) operation piping systems.
- .3 Insulation:
  - .1 Insulation, fastenings, and finishes: same as system.
  - .2 Jacket: As per adjacent insulation.

### 3.4 PIPING INSULATION SCHEDULES

- .1 Includes valves, valve bonnets, strainers, flanges, air separators, and fittings unless otherwise specified.
- .2 Install insulator and jackets to applicable TIAC codes.
- .3 Insulate ends of capped piping with type and thickness indicated for capped service.
- .4 Thickness of insulation to be as listed in following table.
  - .1 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Type	Pipe sizes through (NPS) and insulation thickness mm (")				
		to 25 (1")	32 (1¼") 40 (1½")	50 (2") 80 (3")	105 (4") 150 (6")	200 (8") & over
Condensate	A-1	40 (1½")	40 (1½")	50 (2")	50 (2")	50 (2")
Hot Water Heating	A-1	40 (1½")	50 (2")	50 (2")	50 (2")	50 (2")
Natural gas	A-4	To meet Fire Resistance Requirements				

.5 Finishes: Conform to the following table:

<u>Application</u>	<u>Piping</u>	<u>Valves &amp; Fittings</u>
Exposed indoors	PVC	PVC
Exposed in mech. rooms	PVC	PVC
Concealed indoors	N/A	PVC
Within 300 mm (12") of boiler	CANVAS	CANVAS

.6 Connection: To appropriate TIAC code.

.7 Finish attachments: SS bands, @ 150 mm (6") oc. seals: closed.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ANSI/ASME B16.5, Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch.
- .3 ANSI B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
- .4 ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- .5 ANSI B18.2.1, Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
- .6 ASTM A47/A47M, Specification for Ferritic Malleable Iron Castings.
- .7 ASTM A53/A53M, and A106, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded ERW and Seamless.
- .8 ASTM B32, Specification for Solder Metal.
- .9 ASTM B75M, Specification for Seamless Copper Tube [Metric].
- .10 CSA B149.1, Natural Gas and Propane Installation Code.
- .11 CSA W47.1, Certification of Companies for Fusion Welding of Steel.

**1.2            SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings product data in accordance with general requirements.
- .2 Indicate on manufacturers catalogue literature.

**1.3            CLOSEOUT SUBMITTALS**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.

**Part 2            Products**

**2.1            GAS SERVICE**

- .1 Arrange with the local utility to have the gas service provided from the street to the gas meter where indicated.
- .2 Fees and charges requested by the local utility to provide the gas service and meter.
- .3 Submit all plans as requested by the local utility.
- .4 Utility supplied gas meter shall be complete with pulse signal for connection to BAS system (co-ordinate pulse representation in m<sup>3</sup> of gas used on meter specifications.
- .5 Provide approved pulse gas meter in all locations where indicated on the drawings.

## **2.2 PIPE**

- .1 Steel pipe: to ASTM A106, Schedule 40, seamless as follows:
  - .1 NPS 15 mm to 50 mm (1/2" to 2"), screwed.
  - .2 NPS 65 mm (2 1/2") and over, plain end.
- .2 Buried pipe: CGA approved polypropylene complete with tracer wire and marker.
- .3 Copper tube: to ASTM B75M.

## **2.3 JOINTING MATERIAL**

- .1 Screwed fittings: pulverized lead paste.
- .2 Welded fittings: to CSA W47.1.
- .3 Flange gaskets: nonmetallic flat.
- .4 Soldered: to ASTM B32, tin antimony 95/5.
- .5 Screwed brass fittings: Teflon Tape.

## **2.4 FITTINGS**

- .1 Steel pipe fittings, screwed, flanged or welded:
  - .1 Malleable iron: screwed, banded, Class 150.
  - .2 Steel pipe flanges and flanged fittings: to ANSI/ASME B16.5.
  - .3 Welding: butt-welding fittings.
  - .4 Unions: malleable iron, brass to iron, ground seat, to ASTM A47/A47M.
  - .5 Bolts and nuts: to ANSI B18.2.1.
  - .6 Nipples: schedule 40, to ASTM A53/A53M/A106.
- .2 Copper pipe fittings, screwed, flanged or soldered:
  - .1 Cast copper fittings: to ANSI B16.18.
- .3 Brass fittings: To ASTM B16.

## **2.5 BALL VALVES**

- .1 NPS 50 mm (2") and under:
  - .1 Body and cap: cast high tensile bronze to ASTM B62.
  - .2 Pressure rating: Class 125, 860 kPa (125 psi) steam, WP = 1.4 MPa (203 psi) WOG.
  - .3 Connections: Screwed ends to ANSI B1.20.1 and with hex. shoulders.
  - .4 Stem: tamperproof ball drive.
  - .5 Stem packing nut: external to body.
  - .6 Ball and seat: replaceable stainless steel solid ball and teflon seats.
  - .7 Stem seal: TFE with external packing nut.
  - .8 Operator: removable lever handle.

## **2.6 LUBRICATED PLUG VALVES**

- .1 All sizes
  - .1 Provincial Code approved, lubricated plug type.
  - .2 Body: cast iron to ASTM A 126 Class B semi-steel.
    - .1 Rating: Class 125 psig.
  - .3 Plug: tapered, with regular pattern port – 90 from full open to fully closed.
  - .4 Ends: 50 mm (2") and smaller with hexagon shoulders, ends screwed to ANSI B1.20.1. Flanged to ANSI B16.1.
  - .5 Lubrication system, nickel-plated.
  - .6 Lubricant: to suit type, temperature and pressure of contained fluid.
  - .7 Feeding system: lubricant forced into lubrication grooves between seating surfaces of plug and body to form positive seal, leakproof operation, and corrosion preventing film.
  - .8 Lubricant screw for lubrication.
  - .9 O-rings between body and plug.
  - .10 Operator: removable manual lever handle.
  - .11 Acceptable materials:
    - .1 Newman Hattersley
    - .2 Crane
    - .3 Jenkins
    - .4 Milwaukee
    - .5 Toya

## **2.7 GAS REGULATOR**

- .1 Reduce pressure from 34.5 kPa (5 psi) to 1.74 kPa (7" WC) capacity as indicated.
- .2 Acceptable products:
  - Singer
  - Schlumberger
- .3 Vent interior relief valve to outdoors with gooseneck and stainless steel insect screen. Vent piping shall be sized as per manufacturers' requirements and recommendations.
- .4 Isolate with lubricated plug valve and union connection.

## **2.8 MANUFACTURED ROOF SUPPORTS**

- .1 Single piece injection moulded polypropylene support.
- .2 Type 3-20 psi extruded polystyrene UV protected base glued to the support.
- .3 Minimum base dimension of 300 x 225 (12" x 9") and be 140 mm (5.5") high.
- .4 Pull test of 1.4 KN (315 lbs) using two #14-10 screws on pipe strap.

.5 Acceptable materials:

- .1 Quick Block
- .2 Erico

## **2.9 PIPING THROUGH ROOF**

- .1 Provide Thaler MEF-9 or equal gas piping flashing where pipe and/or relief vent penetrates roof.

## **Part 3 Execution**

### **3.1 PIPING**

- .1 Install in accordance with applicable Provincial/Territorial Codes.
- .2 Install in accordance with CAN/CSA B149.
- .3 Assemble piping using fittings manufactured to ANSI standards.
- .4 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.
- .5 Slope piping down in direction of flow to low points.
- .6 Install drip points:
  - .1 At low points in piping system.
  - .2 At each connection to equipment.
- .7 Use eccentric reducers at pipe size change installed to provide positive drainage.
- .8 Provide clearance for access and for maintenance.
- .9 Ream pipes, clean scale and dirt, inside and out.
- .10 Install piping to minimize pipe dismantling for equipment removal.
- .11 Install regulator vents to code. Terminate in open air with Gooseneck fitting complete with stainless steel screen.
- .12 Paint gas piping with two (2) coats yellow paint. Banding of gas will not be accepted.

### **3.2 PIPING ON ROOF**

- .1 Support piping as follows or as per seismic requirements (1.8 M (6' - 0") O.C.) whichever is more stringent:
  - ≤ 40 mm (1½") 2.4 M (8' - 0") O.C.
  - ≥ 50 mm (2") 3.0 M (10' - 0") O.C.
- .2 Provide support at each elbow and fitting.
- .3 Provide support at each regular and/or isolating valve.
- .4 Provide support within 600 mm (24") of each piece of equipment.

**3.3 VALVES**

- .1 Install valves with stems upright or horizontal unless otherwise approved by Consultant.
- .2 Install valves at branch take-offs to isolate each piece of equipment, and as indicated.
- .3 Provide lubricated plug type when gas line is exterior of building or 65 mm (2½") and larger.
- .4 Provide ball valve when gas line is interior of building and 50 mm (2") or smaller.

**3.4 FIELD QUALITY CONTROL**

- .1 Test system in accordance with CAN/CSA B149. Requirements of authorities having jurisdiction.
- .2 Provide copy of TSSA tag to the consultant.

**3.5 PURGING**

- .1 Purge after pressure test in accordance with CAN/CSA B149.

**3.6 GAS SERVICE**

- .1 Arrange with local gas distributor to install gas service and gas meter. Pay all fees and charges to provide the gas service and gas meter.
- .2 Install all the gas meters where indicated.

**3.7 GAS FIRED EQUIPMENT START-UP**

- .1 Start-up of all new and existing gas fired equipment shall be by this contractor to the requirements of the equipment manufacturer.

**END OF SECTION**

**Part 1 GENERAL**

**1.1 INTRODUCTION**

- .1 The owner is required to inspect and test building gas piping every 10 years and have documentation supporting this work. This school is due for the inspection and documentation.
- .2 The inspection and documentation is to be done by the mechanical contractor and included in the tender price.
- .3 For gas piping installations, appliance installation and venting requirements refer to most current edition of CSA B149.1. This will be the basis for inspections on gas piping.
- .4 These provisions are not intended to be all-inclusive. **When in doubt as to the proper procedure, consult your TSSA Representative or Consultant before proceeding with the work.**
- .5 Any imperfect material or defective or faulty workmanship in the installation will be treated as extra work for gas piping, appliances, appliance connections or appliance venting.

**Part 2 MATERIALS**

**Not applicable.**

**Part 3 EXECUTION**

**3.1 GENERAL**

- .1 The materials, installation and location of the gas piping, appliance, appliance connections or appliance venting shall be subject to requirements of CSA B149.1.
- .2 Gas piping shall be of such size as to provide a supply of gas sufficient to meet the maximum demand with a recommended pressure drop not in excess of 0.3 inch water column between the outlet of the meter set assembly and appliances with 0.6 specific gravity gas.
- .3 CSA B149.1 list the recommended minimum sizes of gas piping to the drop line or connection for heating and/or air conditioning equipment and other types of appliances and should be used unless the complete house line system is sized in accordance to demand.

**3.2 VISUAL INSPECTION**

- .1 The first inspection of any job shall be the visual inspection. In the event the lines will not pass such inspection, or if other unsatisfactory conditions result in the disapproval by the contractor, the necessary correction shall be made and the line involved shall again be inspected by owner and consultant.



- .2 The visual inspection shall include but not limited to the following:
  - .1 Proper sleeving.
  - .2 Condition of gas piping.
  - .3 Proper supports and hangers.
  - .4 Proper venting of PRV's.
  - .5 Identify any concealed location.
  - .6 Proper valving.
  - .7 Pipe size.
  - .8 Proper installation.
  - .9 Proper identification
  - .10 Etc.
- .3 At the time the gas piping are re-inspected by the customer and/or customer's representative, the results of such inspection will be recorded by the contractor on an appropriate form.
- .4 At the time of visual inspection, the entire gas piping system shall be recorded on a drawing indicating all devices, valves, etc. including pipe sizes and device loads.
- .5 A paper drawing or CAD file will be handed to the contractor for mark-ups and identification of the gas piping systems. The contractor will be responsible for providing an AutoCAD drawing of the gas piping system upon completion. The drawing shall indicate:
  - .1 Piping system.
  - .2 Date of testing.
  - .3 Corrective measures taken.
  - .4 Any concealed piping locations.
  - .5 Contractor test name, personal licenses number, contractor's TSSA numbers.
  - .6 Any other pertinent information that should be included on documentation.
- .6 The visual inspection, documentation and corrective measures (i.e. add identification) are all to be included in the tender price.

### **3.3 TESTING GAS PIPING**

- .1 Decommission the gas pipe system.
- .2 Disconnect all appliances from the gas piping system and cap lines.
- .3 Purge gas lines to the outside for testing.
- .4 Provide an air pressure test at 60 psig for 24 hours without a loss of pressure.
- .5 If pressure test has failed, then investigate and report locations of loss.
- .6 If pressure loss is in a screwed fitting or value, then correct valve, lubricate valve, or replace. MUST BE REPORTED AND APPROVED by owner before proceeding.
- .7 If pressure loss is in the piping system, report to the owner.
- .8 Do not provide pressure test thru any PRV valves or appliances.

- .9 After system tested and accepted, then reconnect and return the system to operation.
- .10 Air or an inert gas such as nitrogen shall be used to pressurize the piping. In no case shall oxygen, acetylene or other such gases be used.
- .11 To locate leaks, piping joints should be covered with soapsuds, or a leak-finder liquid. In no case shall ether as an odorant, Freon, or any gas that will produce a toxic atmosphere when burned, be injected into the piping to locate leaks.
- .12 Test pressure must be measured with a manometer or with a pressure-measuring device designed and calibrated to read, record, or indicate a pressure loss caused by leakage during the pressure test period (i.e. a Kuhlman Instrument indicates a pressure loss via fluid rising up the back tube). A standard dial type mechanical pressure gauge indicates pressure, it does not however read, record, or indicate a pressure loss in and of itself.

### **3.4 ABANDONED PIPING**

- .1 Gas piping previously abandoned shall be removed from site.
- .2 Review abandoned service lines with the owner and consultant as it may be advantageous to have piping remain.

### **3.5 VENTING**

- .1 The contractor shall visually inspect the venting from all appliances and provide in writing any deficiencies to the owner and consultant.

### **3.6 EQUIPMENT RESTARTS**

- .1 All equipment shall be restarted and confirmed operating properly at the gas fired burners.
- .2 Where boilers are not familiar to the contractor, notify the owner and ask for assistance from a qualified technician.

### **3.7 COMPLETION**

- .1 Upon completion, the contractor shall provide the TSSA test certificate on the gas piping system and submit copy to the owner and consultant.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 Canadian Standards Association (CSA).
  - .1 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.
- .3 American Society for Testing and Materials (ASTM).
  - .1 ASTM A47/A47M, Specification for Ferritic Malleable Iron Castings.
  - .2 ASTM A278/A278M, Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650°F (350°C).
  - .3 ASTM A516/A516M, Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
  - .4 ASTM A536, Specification for Ductile Iron Castings.
  - .5 ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
- .4 American Society of Mechanical Engineers (ASME).
  - .1 ANSI/ASME, Boiler and Pressure Vessels Code (BPVC).

**1.2 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with general requirements.
- .2 Indicate on manufacturers' catalogue literature the following:
  - .1 Sizes, orientation, capacities, performance, etc.
  - .2 Accessories

**1.3 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.

**Part 2 Products**

**2.1 CLOSED EXPANSION TANK**

- .1 Horizontal expansion tank with threaded pipe connections.
- .2 Quantity, size, and capacity as shown on the drawings.
- .3 Construction:
  - .1 ASME code rated welded tank to 860 kPa (125 psi) test pressure of ASTM A516/A516M, pressure vessel carbon steel plate with dished heads galvanized after manufacture.
  - .2 Conform to: ANSI/ASME BPVC, Section VIII and CSA B51, and provincial regulations.

- .3 Submit certificate of registration as required by [provincial authorities].
- .4 Accessories:
  - .1 Expansion pipe connection at bottom.
  - .2 NPS 25 mm (1") drain connection at bottom with drain valve.
  - .3 Vent connection, NPS 25 mm (1"), at top.
  - .4 Relief valve and connection at top, to manufacturer's recommendations.
  - .5 15 mm (1/2") sight glass connections at 1/8 and 7/8 points of height, complete with sight glass, shut-off valves with blowdown and protective guards.
  - .6 Two - 65 mm (2 1/2") inspection tappings on centre line of sides, one near each end.
- .5 Acceptable Manufactures:
  - .1 Bell and Gossett
  - .2 Armstrong
  - .3 Clemmer

## **2.2 COMBINATION LOW PRESSURE RELIEF AND REDUCING VALVE**

- .1 Adjustable pressure setting: 206 kPa (30 psi) relief, 55 to 172 kPa (8.0 to 25 psi) reducing.
- .2 Low inlet pressure check valve.
- .3 Removable strainer.

## **2.3 PIPELINE STRAINER**

- .1 Pipeline strainer shall provide a means of mechanically removing solids from a flowing fluid. This is accomplished by utilizing a perforated metal mesh.
- .2 Strainers shall be installed in pipelines to protect downstream mechanical equipment such as condensers, heat exchangers, pumps, compressors, meters, spray nozzles, turbines, and steam traps from the detrimental effect of sediment, rust, pipe scale, or other extraneous debris.
- .3 Types of strainers: Provide strainers that are Y strainer and/or basket strainer.
- .4 Strainer end connections shall match the piping specification.
  - .1 NPS 15 mm to 50 mm (1/2" to 2"): bronze body to ASTM B62, screwed connections.
  - .2 NPS 65 mm to 300 mm (2 1/2" to 12"): cast steel body to ASTM A278M, Class 30, flanged connections.
  - .3 NPS 50 mm to 300 mm (2" to 12"): T type with malleable iron body to ASTM A47M, grooved ends.
- .5 Strainer components shall include a cover, perforated plate, mesh, wedge wire, gasket, and cover fasteners.
  - .1 Perforated Plate/Mesh/Wedge Wire: Stainless steel (various grades available).
  - .2 Gaskets: to suite fluid application.

.3 Fasteners: to match body material.

- .6 Mesh sizing: An extremely important consideration in the selection of a strainer is the size of the perforations, mesh or wire opening used in the fabrication of the straining element. Select holes that are actually needed for the application and specified by the equipment manufacturer's request that is being protected.

The following tables illustrate mesh and their respective straining capability. The main criteria for choosing hole and mesh size is the size and quantity of particles which can pass through downstream equipment without causing damage.

Mesh (Openings/In.)	Wire Diameter (In.)	Opening		Percent Open Area
		Inches	Micron	
10	0.032	0.068	727	56.3
16	0.018	0.045	1130	50.7
18	0.017	0.036	979	48.3
20	0.015	0.035	889.0	49.0
30	0.011	0.0223	566.4	44.8
40	0.009	0.0156	396.2	40.2
50	0.009	0.011	279	30.3
60	0.0065	0.0102	259.1	37.3
80	0.005	0.0075	190.5	36.0
100	0.0045	0.0055	139.7	30.3
120	0.0035	0.0048	123	30.1
150	0.0026	0.0041	103	37.2
170	0.0024	0.0035	79	35.1
200	0.0020	0.0030	76.2	33.6
250	0.0016	0.0024	61	36.0
300	0.0012	0.0021	54.2	29.7
325	0.0012	0.0019	47.7	30.0
400	0.0011	0.0014	35.6	36.0

- .7 Capacity: The capacity ratio or open area ratio (OAR) of a strainer influences such operating characteristics as the length of time it can operate without cleaning and the created pressure loss. The OAR is the relationship between internal cross sectional area (flow area) of the pipe and the open flow area of the material which makes up the straining element.

The OAR for wye strainers shall not be less than 2.5:1.

The OAR for basket strainers shall not be less than 7:1.

When considering the OAR of a straining element, there are two accepted methods of analysis used by various specifying agencies and manufacturers. One method maintains "line of sight" reasoning and uses the multiple of the open areas for elements in series. In this method, a 60% open area material in series with a 40% open area material has a resultant combined open area of 24% (i.e. as in accordance with Military Standards). An alternative method allows the open area of the more restrictive element in series to be used. This would be 40% for the example above (i.e. as in accordance with Underwriter Laboratories' Standards). The method used influences the estimated operating pressure drop, as well as design decisions such as sizing.

- .8 Strainers are made with various dimensions and configurations, manufacturers have tested and published pressure drop results.  
  
Provide strainers designed for reasonable velocities that permit approximately 2 psi pressure drop across the strainer.  
  
Provide basket strainers designed for reasonable velocities that permit approximately 0.5 psi pressure drop across the strainer.
- .9 To allow the manufacturer to make selection or recommendations for a particular strainer, as much as possible, the following information should be provided by the Contractor to the Supplier:
  - .1 Physical Characteristics
    - .1 Pipe size and schedule
    - .2 Strainer type required.
    - .3 End connections.
    - .4 Material (body, screen, bolting, gaskets).
    - .5 Pressure rating (design/operating — including shock).
    - .6 Temperature rating (design, operating, minimum).
    - .7 Straining element opening size.
    - .8 Capacity:
      - .1 Net effective open area required.
      - .2 Method of net open area calculation.
    - .9 Special requirements (hinged cover, vent tapping, jacketed, etc.).
    - .10 Applicable specifications (military specifications, special nondestructive tests or other quality control requirements).
  - .2 Flow Data
    - .1 Liquid:
      - .1 Description of fluid.
      - .2 Rate of flow – gallons per minute (gpm) or pounds per hour (lbs/hr).
      - .3 Viscosity – SSU.
      - .4 Specific gravity or density.
      - .5 Temperature.
      - .6 Concentration (if acid or other corrosive).
- .10 Blowdown connection: NPS 25 mm (1").
- .11 Screens at pumps: stainless steel with 1.19 mm (50 mil) perforations (16 mesh).
- .12 Working pressure: 860 kPa (125 psi).

## 2.4 LOW WATER CUT-OFF

- .1 Packaged low water cut-off with heavy duty construction, 16A relay.
- .2 Operates on 24V AC, or 120V switching capacity: 5.8 FLA, 24.8 LRA, Max load: 16A, switch contacts: SPDT, 250 psi max pressure, 250°F max water temperature.

- .3 Burner circuit locks out, if water remains below probe for 30 s. Manual reset will not trip due to power failure.
- .4 Burner circuit test button.
- .5 Indicator lights for troubleshooting.
- .6 Acceptable manufacturer:
  - .1 Hydro Level Company Safgard 500 or 550.

### **Part 3 Execution**

#### **3.1 GENERAL**

- .1 Install as indicated and to manufacturer's recommendations.
- .2 Run drain lines (and blow off connections) to terminate above nearest drain.
- .3 Maintain proper clearance to permit service and maintenance.
- .4 Should deviations beyond allowable clearances arise, request, and follow Consultant's directive.
- .5 Check shop drawings for conformance of all tappings for ancillaries and for equipment operating weights.

#### **3.2 STRAINERS**

- .1 Install in horizontal or down flow lines.
- .2 Ensure clearance for removal of basket.
- .3 Install ahead each of the following components:
  - .1 Pumps
  - .2 Temperature control valves
  - .3 Boilers
  - .4 Meters
  - .5 Additional locations where indicated on the drawings.
- .4 Provide proper mesh strainers for the proper application.
- .5 Provide proper mesh strainers as recommended by the manufacturer's product being protected.
- .6 Provide basket strainers ahead of all plate heat exchanger or equipment with plate heat exchanger when piping is 100 mm (4") and larger.
- .7 The strainer must be installed such that the debris chamber is located at the lowest possible position. A Y strainer in vertical piping must be placed with its screen in the downward position to trap the sediment in the debris collection chamber.
- .8 Provide with a blowdown so the element can be flushed out by opening and closing the blowdown valve. This shall be accomplished without flow stoppage or disassembling any piping.

**3.3 EXPANSION TANKS**

- .1 Adjust expansion tank pressure to suit system pressure at installed location or noted design pressure. Where discrepancies between plans and system pressure exist notify consultant.
- .2 Set pressure in accordance with ASME Boiler and Pressure Vessel Code.
- .3 Ensure boiler temperature and pressure relief is adequate for system at high temperature and pressure. Test operation on site.
- .4 Maintain a minimum of 105 kpa (15 psig) as the lowest pressure point.
- .5 Install isolation ball valve and union at inlet to tank.

**3.4 PRESSURE SAFETY RELIEF VALVES**

- .1 Run discharge pipe to terminate above nearest drain.

**END OF SECTION**



**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 Canadian Standards Association (CSA).
  - .1 CSA W47.1, Certification of Companies for Fusion Welding of Steel.
- .3 American National Standards Institute (ANSI).
  - .1 ANSI/ASME B16.1, Gray Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.
  - .2 ANSI/ASME B16.3, Malleable-Iron Threaded Fittings, Classes 150 and 300.
  - .3 **ANSI/ASME B16.5, Pipe Flanges and Flanged Fittings: NPS½ through NPS24 Metric/Inch.**
  - .4 **ANSI/ASME B16.9, Factory-Made Wrought Steel Buttwelding Fittings.**
  - .5 **ANSI B18.2.1, Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).**
  - .6 **ANSI/ASME B18.2.2, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).**
  - .7 **ANSI/AWWA C111/A21.11, Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.**
- .4 American Society for Testing and Materials (ASTM).
  - .1 ASTM A47/A47M, Specification for Ferritic Malleable Iron Castings.
  - .2 ASTM A53/A53M, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
  - .3 ASTM A536, Specification for Ductile Iron Castings.
  - .4 ASTM B61, Specification for Steam or Valve Bronze Castings.
  - .5 ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
  - .6 **ASTM E202, Test Method for Analysis of Ethylene Glycols and Propylene Glycols.**
- .5 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
  - .1 MSS-SP-67, Butterfly Valves.
  - .2 MSS-SP-70, Cast Iron Gate Valves, Flanged and Threaded Ends.
  - .3 MSS-SP-71, Cast Iron Swing Check Valves, Flanged and Threaded Ends.
  - .4 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.
  - .5 MSS-SP-85, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

## **1.2 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with general requirements.
- .2 Indicate on manufacturers' catalogue literature the following:
  - .1 Piping
  - .2 Valves
  - .3 Accessories

## **1.3 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.

## **Part 2 Products**

### **2.1 STEEL PIPE**

- .1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:
  - .1 NPS 150 mm (6") and smaller: Schedule 40.
  - .2 NPS 200 mm (8") and over, Schedule 30.
- .2 Final connection to copper heating elements.
  - .1 Type "L" copper with 95/5 solder joints and dielectric couplings. Maximum length 600 mm (24").
- .3 Pipe Joints
  - .1 NPS 50 mm (2") and under: screwed fittings with pulverized lead paste.
  - .2 NPS 65 mm (2½") and over: welding fittings and flanges to CSA W47.1.
  - .3 Flanges: plain or raised face, slip-on.
  - .4 Flange gaskets: suitable for hydronic heating up to 110°C (220°F).
  - .5 Pipe thread: taper.
  - .6 Bolts and nuts: to ANSI B18.2.1 and ANSI/ASME B18.2.2.
- .4 Fittings
  - .1 Screwed fittings: malleable iron, to ANSI/ASME B16.3, Class 150.
  - .2 Pipe flanges and flanged fittings:
    - .1 Cast iron: to ANSI/ASME B16.1, Class 125.
    - .2 Steel: to ANSI/ASME B16.5.
  - .3 Butt-welding fittings: steel, to ANSI/ASME B16.9.
  - .4 Unions: malleable iron, to ASTM A47/A47M and ANSI/ASME B16.3.

## 2.2 VALVES

- .1 Connections:
  - .1 NPS 32 mm (1 1/4") and smaller: screwed ends.
  - .2 NPS 50 mm (2") and smaller: screwed ends.
  - .3 NPS 65 mm (2 1/2") and larger: flanged ends.
- .2 Gate valves: Application: Isolating equipment, control valves, pipelines:
  - .1 NPS 50 mm (2") and under:
    - .1 Mechanical Rooms: Class 125, rising stem, solid wedge disc.
    - .2 Elsewhere: Class 125, non-rising stem, solid wedge disc.
  - .2 NPS 65 mm (2 1/2") and over:
    - .1 Mechanical Rooms:
      - .1 Rising stem, solid wedge disc, bronze trim.
        - .1 Operators: handwheel.
      - .2 Non-rising stem, solid wedge disc, bronze trim.
        - .1 Operators: handwheel.
- .3 Butterfly valves: Application: Isolating each cell or section of multiple component equipment and where indicated.
  - .1 NPS 32 mm (1 1/4") and smaller: screwed ends.
  - .2 NPS 50 mm (2") and smaller: screwed ends.
  - .3 NPS 65 mm (2 1/2") and over: Flanged ends.
- .4 Globe valves: Application: Throttling, flow control, emergency bypass:
  - .1 NPS 50 mm (2") and under:
    - .1 With PTFE disc, as specified. Bronze.
  - .2 NPS 65 mm (2 1/2") and over:
    - .1 With solid bronze disc, bronze trim, cast iron body.
- .5 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc, with chain and cap.
- .6 Swing check valves:
  - .1 NPS 50 mm (2") and under:
    - .1 Class 150, swing, with PTFE disc, as specified. Bronze. Jenkins 4475TJ.
  - .2 NPS 65 mm (2 1/2") and over:
    - .1 Flanged or Grooved ends, Bronze trim, Cast Iron: Gate, Globe, Check.
- .7 Ball valves:
  - .1 NPS 80 mm (3") and under:
    - .1 Body and cap: cast high tensile bronze to ASTM B62.
    - .2 Pressure rating: Class 125, 860 kPa (125 psi) steam, WP = 1.4 MPa (203 psi) WOG.

- .3 Connections:
  - .1 NPS 50 mm (2") and under screwed ends to ANSI B1.20.1 and with hex. shoulders.
  - .2 NPS 65 mm (2½") and over flanged or grooved ends.
  - .4 Stem: stainless steel tamperproof ball drive.
  - .5 Ball and seat: replaceable stainless steel solid ball and teflon seats.
  - .6 Operator: removable lever handle.
  - .7 Extended handles on chilled water valves.
  - .8 Full port.
- .8 All valves shall be of commercial grade and of same manufacturer.
- .9 Acceptable Manufacturers:
  - .1 Newman Hattersley Canada Ltd.
  - .2 Jenkins/Crane
  - .3 Milwaukee
  - .4 Toyo
  - .5 Kitz

## **2.3 BALANCING VALVES**

- .1 Size 15 mm (1/2") to 50mm (2"): Bronze body, brass ball, NPT connections and variable orifice.
- .2 Size 65 mm (2 1/2") to larger: Cast iron body, raised flange connections, glove style with brass plug.
- .3 Differential pressure readout ports with internal EPT inserts and check valves, 6 mm (¼")NPT tapped drain/purge ports, memory stop and calibrated nameplate.
- .4 Acceptable materials:
  - .1 Bell & Gossett Circuit Setters
  - .2 Armstrong
  - .3 Taco
  - .4 Tour & Anderson
  - .5 Oventrop

## **2.4 TRIPLE DUTY VALVE**

- .1 Straight pattern, combination check, throttling shut off and calibrated balancing valve, heavy duty cast iron construction with standard 125 psig ANSI flanged connections rated for maximum working pressure of 175 psig at 250°F.
- .2 Valve shall be fitted with a replaceable bronze disk with EPDM seat insert, stainless steel stem and chatter preventing spring. Valve design shall permit replacing under full system pressure.

- .3 Valve shall be equipped with brass readout valves (with integral check valves).

- .1 Acceptable material  
Bell & Gossett  
Armstrong

## **2.5 AUTOMATIC AIR VENT**

- .1 Industrial float vent: cast iron body and NPS 15 mm (1/2") connection and rated at 860 kpa (125 psi) working pressure.
- .2 Float: solid material suitable for 115°C (240°F) working temperature.
- .3 Plastic vents are not acceptable.
- .4 Acceptable materials:
  - .1 Maid-O-Mist No. 67
  - .2 Spirax Sarco

## **Part 3 Execution**

### **3.1 PIPING INSTALLATION**

- .1 Installation shall be by a licensed pipe fitter.
- .2 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.
- .3 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping wherever practical.
- .4 Slope piping in direction of drainage and for positive venting.
- .5 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.
- .6 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.
- .7 Ream pipes, clean scale and dirt, inside and outside, before and after assembly.
- .8 Assemble piping using fittings manufactured to ANSI standards.
- .9 Saddle type branch fittings may be used on mains if branch line is no larger than half the size of main. Hole saw or drill and ream main to maintain full inside diameter of branch line prior to welding saddle.

### **3.2 VALVE INSTALLATION**

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Install butterfly valves on chilled water and condenser water lines only.
- .3 Install gate or ball valves at branch take-offs and to isolate each piece of equipment, and as indicated.

- .4 Install globe valves for balancing and in by-pass around control valves as indicated.
- .5 Provide silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.
- .6 Provide swing check valves in horizontal lines as indicated.
- .7 Install chain operators on valves NPS 65 mm (2½") and over where installed more than 2400 mm (96") above floor in Boiler Rooms and Mechanical Equipment Rooms.
- .8 Provide ball valves for glycol service.

### **3.3 AIR VENTS**

- .1 Install at high points of systems.
- .2 Install ball valve on automatic air vent inlet.
- .3 Extend vent lines in Mechanical Room with screwdriver stop at 1.8 m AFF.

### **3.4 CIRCUIT BALANCING VALVES**

- .1 Install flow measuring stations and flow balancing valves as indicated.
  - .1 On return side of all heating devices (convectors, panels, force flows, radiation, coils, etc.).
  - .2 On return side of all water or glycol cooling coils.
  - .3 On return side of all reverse return piping loops and/or branch circuits.
- .2 Install to manufacturers requirements.
- .3 Minimum valve size shall be one pipe size smaller than piping or 20 mm (¾"), whichever is larger.
- .4 Refer to Testing Adjusting and Balancing Section for applicable procedures.

### **3.5 FILLING OF SYSTEM**

- .1 Refill system with clean water adding water treatment as specified.
- .2 Co-ordinate filling of system with HVAC water treatment contractor.

### **3.6 TESTING**

- .1 Test system in accordance with Mechanical General Requirements Section.
- .2 For glycol systems, retest with propylene glycol to ASTM E202, inhibited, for use in building system after cleaning. Repair any leaking joints, fittings or valves.

### **3.7 FLUSHING AND CLEANING**

- .1 Scope:
  - .1 **Drain and flush entire existing system and new piping.**
- .2 Refer to Water Treatment Section

- 
- .3 Procedure:
    - .1 Flushing and cleaning should only take place after successful piping pressure testing.
    - .2 Terminal device (reheat coils, heat pumps, perimeter radiation, etc.), air handling unit coils and their associated control and balancing valves should be bypassed during the preliminary flushing and cleaning process.
    - .3 Instruments such as flow meters, flow metering valves and orifice plates should only be installed after flushing and cleaning.
  - .4 Timing:
    - .1 The overall construction schedule identifies piping flushing and cleaning with realistic time allotments.
    - .2 The mechanical contractor is required to provide a detailed report outlining the processes and procedures for flushing and cleaning per piping system at least 4 to 6 weeks in advance of work.
    - .3 As a minimum, at least one piping flushing and cleaning procedure shall be witnessed, by the consultant and/or commissioning agent.
  - .5 The mechanical contractor shall to utilize a qualified water treatment specialist to supervise the flushing and cleaning process and provide the certified water analysis report certifying that the piping systems are clean.
  - .6 Coordinate flushing and cleaning of mechanical systems with HVAC water treatment contractor and HVAC systems commissioning contractor.
  - .7 Flush and clean new piping system in presence of Consultant.
  - .8 Flush after pressure test for a minimum of 4 hrs.
  - .9 Fill system with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8 hrs.
  - .10 Thoroughly flush all new mechanical systems and equipment with approved cleaning chemicals designed to remove deposition from construction such as pipe dope, oils, loose mill scale and other extraneous materials. Chemicals to inhibit corrosion of various system materials and be safe to handle and use.
  - .11 During circulation of cleaning solution, periodically examine and clean filters and screens and monitor changes in pressure drop across equipment.
  - .12 Refill system with clean water. Circulate for at least 2 hours. Clean out strainer screens/baskets regularly. Then drain.
  - .13 Drainage to include drain valves, dirt pockets, strainers, every low point in system.
  - .14 Drain and flush systems until alkalinity of rinse water is equal to make-up water. Refill with clean water treated to prevent scale and corrosion during system operation.
  - .15 Re-install strainer screens/baskets only after obtaining Consultant's approval and approval from HVAC water treatment contractor.
  - .16 Repeat system drain and flush as often as necessary to have a clean system.
  - .17 Disposal of cleaning solutions to be approved by authority having jurisdiction.

- .18 Isolate new piping system from existing system as required for system cleaning.
- .19 **After hydronic system is cleaned, refill with clean water and chemical as per chemical supplier treatment.**

**3.8 EXISTING SYSTEM DISPOSAL**

- .1 Disposal of existing system shall be to the requirements of the local and/or provincial regulations.

**END OF SECTION**



**Part 1            General**

**1.1            SHOP DRAWINGS AND PRODUCT DATA**

- .1      Submit shop drawings and product data in accordance with General Requirements.
- .2      Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories, and controllers.
- .3      Submit product data of pump curves for review showing point of operation.
- .4      Indicate piping, valves and fittings shipped loose by packaged equipment supplier, showing their final location in field assembly.

**1.2            MAINTENANCE DATA**

- .1      Provide maintenance data for incorporation into manual specified in general requirements.

**Part 2            Products**

**2.1            IN-LINE CIRCULATORS**

- .1      Volute: bronze radially split, with screwed or flanged design suction and discharge connections.
- .2      Impeller: bronze.
- .3      Shaft: alloy steel with copper sleeve bearing, integral thrust collar.
- .4      Seal assembly: mechanical for service to 135°C (275°F).
- .5      Coupling: flexible self-aligning.
- .6      Motor: resilient mounted, drip proof, sleeve bearing, as indicated.
- .7      Capacity: as indicated.
- .8      Design pressure: 1207 kPa (175 psi).
- .9      Acceptable material:
  - .1          Bell & Gossett Model
  - .2          Armstrong

**2.2            VERTICAL IN-LINE CIRCULATORS**

- .1      Volute: cast iron radially split, with tapped openings for venting, draining and gauge connections, with screwed or flanged suction and discharge connections.
- .2      Impeller: brass or bronze.
- .3      Shaft: stainless steel with bronze sleeve bearing, integral thrust collar.
- .4      Seal assembly: mechanical for service to 135°C (275°F).

- .5 Coupling: flexible self-aligning.
- .6 Motor: resilient mounted, drip proof, sleeve bearing, as indicated
- .7 Capacity: as indicated.
- .8 Design pressure: 1200 kPa (175 psi).
- .9 Acceptable material:
  - .1 Bell & Gossett Model
  - .2 Armstrong
  - .3 Darling

### **2.3 SUCTION DIFFUSER**

- .1 Body: cast iron with flanged connections.
- .2 Construction Strainer: with built-in disposable construction 1.19 mm (3/64") mesh no. 16, low pressure drop screen (maximum 2 psig) and NPS 25 mm (1") blowdown connection.
- .3 System Strainer: Provide permanent 3.0 mm perforated stainless steel strainer (mesh no. 7) with maximum pressure drop of 1 psig.
- .2 Permanent magnet particle trap.
- .3 Full length straightening vanes.
- .4 Pressure gauge tapings.
- .5 Adjustable support leg.
- .6 Angle orientation. Line size inlet and pump suction size outlet.
- .7 Acceptable Material:
  - .1 To match pump supplier.

### **2.4 TRIPLE DUTY VALVES**

- .1 Body: Cast iron with flanged connections. Straight pattern combination shut off, non slam check and calibrated balance valve.
- .2 Brass seat, bronze disk with EPDM seat insert.
- .3 Brass stem, stainless steel spring, teflon-graphite packing.
- .4 Brass readout valve.
- .5 Straight orientation when installed in discharge piping downstream of pump. Line size inlet and outlet.
- .6 Angle orientation when installed at pump outlet. Pump discharge size inlet and line size outlet.
- .7 Acceptable material:
  - .1 To match pump supplier.

---

**Part 3                      Execution**

**3.1                      INSTALLATION**

- .1        In line circulators: install as indicated by flow arrows. Support at inlet and outlet flanges or unions. Install with bearing lubrication points accessible suction discharge in vertical alignment.
- .2        Base mounted type: supply templates for anchor bolt placement. Furnish anchor bolts with sleeves. Place level, shim unit and grout. Align coupling in accordance with manufacturer's recommended tolerance. Check oil level and lubricate. After run-in, tighten glands.
- .3        Ensure that pump body does not support piping or equipment. Provide stanchions or hangers for this purpose. Refer to manufacturer's installation instructions for details.
- .4        Pipe drain tapping to floor drain complete with isolating valve.
- .5        Install volute venting pet cock in accessible location.
- .6        Check rotation prior to start-up.
- .7        Install pressure gauge with plug cocks on inlet and outlet on pump.

**3.2                      SUCTION DIFFUSERS**

- .1        Install on inlet to pumps.
- .3        Clean hydronic system with both strainers installed (mesh 16 and mech 17).
- .4        Remove construction screen strainer (mesh 16) from inlet suction guide after system cleaned and before balancing. Mount mesh 16 strainer on wall for future cleaning use

**3.3                      TRIPLE DUTY VALVES**

- .1        Valves shall be straight pattern.
- .2        Provide 4x pipe diameter spool piece between pump discharge and triple duty valve.
- .3        Leave valves open for T.A.B to set.

**3.4                      INLINE PUMPS**

- .1        Install all inline pumps with isolation valves, inlet strainers, reducers/increasers, and pressure gauges on both sides.

**3.5                      PUMP INSTALLATION**

- .1        Install pumps to manufacturer's recommendation.

**3.6                      PUMP VIBRATION**

- .1        Install pumps isolated from the piping system when larger than 2" piping main.
- .2        Install pumps on vibration isolators and flex connectors when greater than 3.0 HP.
- .3        Install pumps on an inertia pad when on an upper floor level and 3.0 HP or greater. Pumps mounted on slab, on grade, for 3.0 HP or greater can be on spring isolator base.

- .4 All pumps 15 HP and greater shall be installed on inertia base regardless of location in building.

### **3.7 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.

**END OF SECTION**

**Part 1 General****1.1 RELATED SECTIONS**

- .1 Plumbing Specialties and Accessories.
- .2 Hydronic Systems – Steel.

**1.2 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 American Society of Mechanical Engineers (ASME).
- .3 ANSI/ASME Boiler and Pressure Vessel Code, Section VI.

**1.3 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with general requirements.

**1.4 CLOSEOUT SUBMITTALS**

- .1 Submit operation and maintenance data for incorporation into manual specified in general requirements
- .2 Include following:
  - .1 Log sheets as recommended by manufacturer.
  - .2 Test reports.

**Part 2 Products****2.1 MANUFACTURER**

- .1 Equipment, chemicals, service by one supplier.
- .2 Acceptable manufacturer:
  - .1 **Aquarian Chemicals (905-825-3711) No alternates.**

**2.2 CHEMICAL FEED PIPING**

- .1 Resistant to chemicals employed. Pressure rating: 1200 kPa (175 psi).

**2.3 CHEMICALS**

- .1 Provide 1 year's supply.

**2.4 TEST EQUIPMENT**

- .1 Provide one set of test equipment for each system to verify performance.
- .2 Complete with carrying case, reagents for chemicals, all specialized or supplementary equipment.

**2.5 CLEANING CHEMICALS**

- .1 Provide as required to make system clean.
- .2 Cleaner chemical: compatible and of the same manufacturer of the water treatment supplier.

**2.6 RECORD MANAGEMENT**

- .1 Provide cards and card holder mounted on wall adjacent to each pot feeder.

**Part 3 Execution****3.1 WATER TREATMENT SERVICES**

- .1 After entire new and existing system is cleaned as specified elsewhere, provide monthly water treatment monitoring and consulting services for period of one year after system start-up. Provide written report to consultant after each visit. Service to include:
  - .1 Initial water analysis and treatment recommendations.
  - .2 System start-up assistance.
  - .3 On site system testing and recording of treated hydronic system.
  - .4 Operating staff training.
  - .5 Visit plant every 7 days during first month of operation and as required until system stabilizes, and advise consultant in writing on treatment system performance.
  - .6 Provide monthly visits with reports after system has stabilized to the satisfaction of the owner.
  - .7 Provide necessary monthly recording charts and log sheets for one year operation.
  - .8 Provide necessary laboratory and technical assistance.
  - .9 Instructions and advice to operating staff to be clear, concise and in writing.

**3.2 START-UP**

- .1 Start up water treatment systems in accordance with manufacturer's instructions.

**3.3 SYSTEM COMMISSIONING AND TRAINING**

- .1 Commissioning and training shall be provided by installing water treatment sub-contractor and water treatment supplier.
- .2 Timing:
  - .1 After start-up deficiencies rectified.
  - .2 After start-up and before TAB of connected systems.

- .3 Pre-commissioning Inspections:
  - .1 Verify:
    - .1 Presence of test equipment, reagents, chemicals, details of specific tests to be performed, operating instructions.
    - .2 Suitability of log book.
    - .3 Currency and accuracy of initial water analysis.
    - .4 Required quality of treated water.
- .4 Commissioning procedures - applicable to all Water Treatment Systems:
  - .1 Establish, adjust as necessary and record all automatic controls and chemical feed rates.
  - .2 Monitor performance continuously during commissioning of all connected systems and until acceptance of project.
  - .3 Establish test intervals, regeneration intervals.
  - .4 Record on approved report forms all commissioning procedures, test procedures, dates, times, quantities of chemicals added, raw water analysis, treated water analysis, test results, instrument readings, adjustments made, results obtained.
  - .5 Establish, monitor and adjust automatic controls and chemical feed rates as necessary.
  - .6 Visit project at monthly intervals after commissioning is satisfactorily completed to verify that performance remains as set during commissioning (more often as required until system stabilizes at required level of performance).
  - .7 Advise Engineer in writing on all matters regarding installed water treatment systems.
- .5 Training:
  - .1 Commission systems, perform tests in presence of, and using assistance of, assigned O&M personnel.
  - .2 Train O&M personnel in softener regeneration procedures.
- .6 Certificates:
  - .1 Upon completion, furnish certificates confirming satisfactory installation and performance.
- .7 Commissioning Reports:
  - .1 To include system schematics, test results, test certificates, raw and treated water analyses, design criteria, all other data required by Consultant.
- .8 Commissioning activities during Warranty Period:
  - .1 Check out water treatment systems on regular basis and submit written report to Consultant.

### **3.4 CLEANING OF MECHANICAL SYSTEM**

- .1 Coordinate cleaning of mechanical systems with mechanical contractor.

- .2 Provide copy of recommended cleaning procedures and chemicals for approval by Consultant.
- .3 Procedure:
  - .1 Flushing and cleaning should only take place after successful piping pressure testing.
  - .2 Terminal device (reheat coils, heat pumps, perimeter radiation, heat exchangers etc.), air handling unit coils and their associated control and balancing valves should be bypassed during the preliminary flushing and cleaning process.
  - .3 Instruments such as flow meters, flow metering valves and orifice plates should only be installed after flushing and cleaning.
- .4 Timing:
  - .1 The overall construction schedule identifies piping flushing and cleaning with realistic time allotments.
  - .2 The mechanical contractor is required to provide a detailed report outlining the processes and procedures for flushing and cleaning per piping system at least 4 to 6 weeks in advance of work.
  - .3 As a minimum, at least one piping flushing and cleaning procedure shall be witnessed, by the consultant and/or commissioning agent.
- .5 The mechanical contractor shall to utilize a qualified water treatment specialist to supervise the flushing and cleaning process and provide the certified water analysis report certifying that the piping systems are clean.
- .6 Coordinate flushing and cleaning of mechanical systems with HVAC water treatment contractor.
- .7 Flush and clean new piping system in presence of Owner
- .8 Flush after pressure test for a minimum of 4 hrs.
- .9 Fill system with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8 hrs.
- .10 Thoroughly flush all new mechanical systems and equipment with approved cleaning chemicals designed to remove deposition from construction such as pipe dope, oils, loose mill scale and other extraneous materials. Chemicals to inhibit corrosion of various system materials and be safe to handle and use.
- .11 During circulation of cleaning solution, periodically examine and clean filters and screens and monitor changes in pressure drop across equipment.
- .12 Refill system with clean water. Circulate for at least 2 hours. Clean out strainer screens/baskets regularly. Then drain.
- .13 Drainage to include drain valves, dirt pockets, strainers, every low point in system.
- .14 Drain and flush systems until alkalinity of rinse water is equal to make-up water. Refill with clean water treated to prevent scale and corrosion during system operation.
- .15 Reinstall strainer screens/baskets only after obtaining Owner's approval and approval from HVAC water treatment contractor and board chemical treatment technician.



- .16 Repeat system drain and flush as often as necessary to have a clean system.
- .17 Disposal of cleaning solutions to be approved by authority having jurisdiction.
- .18 Isolate new piping system from existing system as required for system cleaning.

### **3.5 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:

One (1) year warranty period applies.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 SMACNA HVAC Duct Construction Standards, Metal and Flexible.
- .3 SMACNA HVAC Duct Leakage Test Manual.
- .4 ASTM A480/A480M, Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
- .5 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process. (Metric).
- .6 ANSI/NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
- .7 ANSI/NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems.

**1.2            SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with Section general requirements.
- .2 Indicate following:
  - .1 Sealants
  - .2 Tape
  - .3 Proprietary Joints
  - .4 Fittings

**1.3            CERTIFICATION OF RATINGS**

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

**Part 2            Products**

**2.1            DUCTWORK**

- .1 Galvanized Steel:
  - .1 Galvanized steel with Z90 designation zinc coating lock forming quality: to ASTM A653/A653M.

.2 Thickness:

Size Type	Class A Gauge	Class B Gauge	Class C Gauge
<b>Square and Rectangular</b>			
Up to 600 mm (24")	22	24	24
625 mm to 1000 mm (25" to 40")	20	22	24
1025 mm to 1800 mm (41" to 72")	18	20	22
1825 mm to 2400 mm (73" to 96")	16	18	20
2450 mm and over (97")	16	16	16
<b>Round and Oval</b>			
Up to 300 mm (12")	24	24	24
325 mm to 600 mm (13" to 24")	22	24	24
625 mm to 900 mm (25" to 36")	20	22	24
925 mm to 1200 mm (37" to 48")	18	20	22
1225 mm (49") and over	18	18	20

- .3 All ductwork between HVAC unit connections and 3.0 m (10'-0") downstream or to silencers shall be 1.4 mm (18 gauge).

.2 Aluminum

- .1 To ASHRAE and SMACNA. Aluminum type: 3003-H-14.
- .2 Thickness, fabrication and reinforcement: to ASHRAE and SMACNA or as indicated.
- .3 Joints: to ASHRAE and SMACNA.
- .1 Acceptable material:
- .1 Ductmate Canada Ltd.
- .4 Foil tape all transverse and longitudinal joints.

## 2.2 DUCT CONSTRUCTION

- .1 Round and oval:
- .1 Ducts: factory fabricated, spiral wound, with matching fittings and specials to SMACNA.
- .2 Transverse joints up to 900 mm (36"): slip type with tape and sealants.
- .3 Transverse joints over 900 mm (36"): Ductmate or Exanno Nexus Duct System.
- .2 Square and rectangular:
- .1 Ducts: to SMACNA.
- .2 Transverse joints, longest side:  
 up to and including 750 mm (30"): SMACNA proprietary duct joints.

- .3 Ducts with sides over 750 mm (30") to 1200 mm (48"), transverse duct joint system by Ductmate/25, Nexus, or WDCI (Lite) (SMACNA "E" or "G" Type connection). Weld all corners.
  - .1 Acceptable materials:
    - .1 Ductmate Canada Ltd.
    - .2 Nexus, Exanno Corp.
    - .3 WDCI
- .4 Ducts 1200 mm (48") and larger, Ductmate/35, Nexus, or WDCI (heavy) (SMACNA "J" Type connection). Weld all corners.
  - .1 Acceptable materials:
    - .1 Ductmate Canada Ltd.
    - .2 Nexus, Exanno Corp.
    - .3 WDCI.

## 2.3 FITTINGS

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows:
  - .1 Rectangular: standard radius and or short radius with single thickness turning vanes Centreline radius: 1.5 times width of duct.
  - .2 Round:
    - .1 In exposed areas one-piece smooth radius, 1.5 times diameter.
    - .2 In concealed areas 3-piece adjustable, 1.5 times diameter.
- .3 Mitred elbows, rectangular:
  - .1 To 400 mm (16"): with double thickness turning vanes.
  - .2 Over 400 mm (16"): with double thickness turning vanes.
- .4 Branches:
  - .1 Rectangular main and branch: with 45° entry on branch.
  - .2 Round main and branch: enter main duct at 45° with conical connection.
  - .3 Provide volume control damper in branch duct near connection to main duct.
  - .4 Main duct branches: with splitter damper.
- .5 Diffuser connection to main:
  - .1 90° round spin in collars with balancing damper and locking quadrant.
- .6 Transitions:
  - .1 Diverging: 20° maximum included angle.
  - .2 Converging: 30° maximum included angle.
- .7 Offsets:
  - .1 Full short radiused elbows.
- .8 Obstruction deflectors: maintain full cross-sectional area.

## 2.4 SEAL CLASSIFICATION

### .1 Classification as follows:

Maximum Pressure Pa (" w.c.)	SMACNA Seal Class	Acceptable Leakage Classification (Rectangular)	Acceptable Leakage Classification (Round)
2500 (10")	A	4	2
1500 (6")	A	4	2
1000 (4")	A	4	2
750 (3")	A	8	4
500 (2")	B	16	8
250 (1")	B	16	8
125 (0.5")	C	16	8

### .2 Seal classification:

- .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.
- .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant.
- .3 Class C: transverse joints and connections made air tight with gaskets, or sealant or combination thereof. Longitudinal seams sealed with foil tape or sealant.

## 2.5 SEALANT

- .1 Sealant: oil resistant, polymer type flame resistant duct sealant. Temperature range of -30°C (-22°F) to plus 93°C (199°F).
- .2 Flame-spread rating not more than 25.
- .3 Smoke developed classification not more than 50.
- .4 Acceptable materials:
  - .1 Duro Dyne S-2
  - .2 Foster

## 2.6 TAPE

- .1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm (2") wide.
  - .1 Acceptable material:
    - .1 Duro Dyne FT-2

## 2.7 DUCT LEAKAGE

- .1 In accordance with SMACNA HVAC Duct Leakage Test Manual.

## 2.8 FIRESTOPPING

- .1 40 mm x 40 mm x 3 mm (1½" x 1½" x 16ga) retaining angles all around duct, on both sides of fire separation.
- .2 Firestopping material and installation must not distort duct.
- .3 All ductwork passing through partition walls shall be firestopped.

## 2.9 KITCHEN EXHAUST SYSTEMS

- .1 Construct in accordance with ANSI/NFPA 96.
- .2 Material: Type 316 stainless steel sheet or carbon steel.
- .3 Clearance: 450 mm (18") to combustible materials or protected to NFPA 96 requirements.
- .4 Fabrication: as indicated.

## 2.10 WATERTIGHT DUCT

- .1 Provide watertight duct for:
  - .1 Dishwasher exhaust.
  - .2 Fresh air intake.
  - .3 Minimum 3000 mm (120") from duct mounted humidifier in all directions.
  - .4 As indicated.
- .2 Form bottom of horizontal duct without longitudinal seams. Solder or weld joints of bottom and side sheets. Seal all other joints with duct sealer.

## 2.11 HANGERS AND SUPPORTS

- .1 Band hangers: use on round and oval ducts only up to 500 mm (20") diameter, of same material as duct but next sheet metal thickness heavier than duct.
- .2 DUCTMATE "Clutcher" cable hanging system may be utilized on round ductwork up to 450mm (18 inch) diameter in areas of exposed ceilings where lateral movement/loads on ductwork is not present (such as those caused by attached linear diffusers).
- .3 Trapeze hangers: ducts over 500 mm (20") diameter or longest side, to ASHRAE and SMACNA.
- .4 Hangers: galvanized steel angle with black steel rods to ASHRAE and SMACNA following table:

Duct Size mm (")	Angle Size mm (")	Rod Size mm (")
up to 750 (30)	25 x 25 x 3 (1 x 1 x 1/8)	6 (1/4)
>750 to 1050 (>30 to 42)	40 x 40 x 3 (1½ x 1½ x 1/8)	6 (1/4)
>1050 to 1500 (>42 to 60)	40 x 40 x 3 (1½ x 1½ x 1/8)	10 (3/8)
>1500 to 2100 (>60 x 84)	50 x 50 x 3 (2 x 2 x 1/8)	10 (3/8)
>2100 to 2400 (>84 x 96)	50 x 50 x 5 (2 x 2 x 1/8)	10 (3/8)
>2400 (96) and over	50 x 50 x 6 (2 x 2 x ¼)	10 (3/8)

- .5 Upper hanger attachments:
  - .1 For concrete: manufactured concrete inserts.
    - .1 Acceptable material:
      - .1 Myatt fig. 485
  - .2 For steel joist: manufactured joist clamp or steel plate washer.
    - .1 Acceptable material:
      - .1 Grinnell fig. 61 or 60
  - .3 For steel beams: manufactured beam clamps:
    - .1 Acceptable material:
      - .1 Grinnell Fig. 60

### **Part 3 Execution**

#### **3.1 GENERAL**

- .1 The following systems shall conform to these requirements:

System	Class	Material
VAV Supply	A	Galvanized steel
HVAC Supply and Return	B	Galvanized steel
General Exhaust	B	Galvanized steel
Ventilation Plenum	B	Galvanized steel
Exhaust Plenum	B	Galvanized steel
Individual Exhaust	C	Galvanized steel

- .2 Do work in accordance with ASHRAE and SMACNA.
- .3 Do not break continuity of insulation vapour barrier with hangers or rods.
- .4 Support risers in accordance with ASHRAE and SMACNA.
- .5 Install breakaway joints in ductwork on each side of fire separation.
- .6 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .7 Manufacture duct in lengths to accommodate installation of acoustic duct lining.

#### **3.2 HANGERS**

- .1 Strap hangers: install in accordance with SMACNA.
- .2 Angle hangers: complete with locking nuts and washers.

- .3 Hanger spacing: in accordance with ASHRAE, SMACNA and as follows:

Duct Size	Spacing
mm (")	mm (")
to 1500 (60")	3000 (120")
over 1500 (60")	2500 (100")

- .4 Do not support ductwork over 250 mm x 250 mm (10" x 10") from roof deck.

### **3.3 CLUTCHER CABLE HANGER**

- .1 Do not install in corrosive environments such as pools, aquariums or spas.
- .2 Utilize the standard loop hanging style. (limited to 450mm (18") diameter)
- .3 Contractor is responsible to calculate required clutcher and cable weight rating based on manufacturer selection guidelines. Minimum weight rating of system components shall be 250 lbs.
- .4 Maximum Hanger Spacing: 3000 mm (120")
- .5 Provide additional rigid supports as required if lateral movement in the ductwork occurs.

### **3.4 WATERTIGHT DUCT**

- .1 Slope horizontal branch ductwork down towards hoods served. Slope header ducts down toward risers.
- .2 Fit base of riser with 150 mm (6") deep drain sump and 25 mm (1") drain connected, with deep seal trap and valve and discharging to open funnel drain.

### **3.5 SEALING**

- .1 Apply sealant to outside of joint to manufacturer's recommendations.
- .2 Bed tape in sealant and recoat with minimum of 1 coat of sealant to manufacturers recommendations.

### **3.6 LEAKAGE TESTS**

- .1 Co-ordinate leakage testing with TAB contractor **and commissioning agent**. TAB contractor will be responsible for all duct testing.
- .2 Duct to be tested in accordance with SMACNA HVAC Duct Leakage Test Manual.
- .3 Leakage tests to be done in sections.
- .4 Trial leakage tests to be performed as instructed to demonstrate workmanship.
- .5 Install no additional ductwork until trial test has been passed.
- .6 Test section to be minimum of 15 m (50'-0") long with not less than 3 branch takeoffs and two 90° elbows. Maximum test length and area to be determined by BAS testing equipment. Allow for twelve (12) tests.
- .7 Complete test before insulation or concealment.



- .8 Provide all necessary end caps and fittings as required for the TAB contractor. Remove same after successful completion of duct test.
- .9 Pressure test ductwork to 1½ times operating pressure (minimum pressure 500 Pa (2" wc) all systems).

### **3.7 CLEANING**

- .1 Keep ducts clear from dust and debris
- .2 Keep duct liner clean from dust, debris, and moisture.
- .3 At completion of project vacuum ducts if dirt or dust is present.
- .4 Where new systems connect into existing systems the existing systems shall be cleaned and vacuumed prior to reconnection. **The extent of the cleaning shall be limited to the area immediately surrounding the new connection point.**
- .5 Ensure all systems are clean prior to start up.

### **3.8 ROOF MOUNTED DUCT SUPPORT**

- .1 Provide zero penetration duct support on roof where indicated.
- .2 Base shall be made of high density polypropylene with UV protection.
- .3 Frames shall be galvanized. All fastenings, rods, nuts, washers, etc. shall be stainless steel.
- .4 Provide shop drawings as specified. Install to manufacturers recommendations.
- .5 Acceptable materials:
  - .1 Portable pipe hanger
  - .2 Bigfoot systems
  - .3 Trikon Systems

### **3.9 INSTALLATION REQUIREMENTS**

- .1 All ductwork is to be protected from the weather and precipitation. The top and sides of all ductwork are to be completely covered with 6mil poly to the satisfaction of the consultant. Maintain protection of the ductwork until the building is made watertight and hollow cores drained. Tape all joints.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 ASTM C423, Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
- .4 ASTM E90, Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- .5 ASTM E477, Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.

**1.2 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with general requirements.
- .2 Provide separate shop drawings for each piece of attenuation equipment complete with product data.

**1.3 PERFORMANCE RATING DATA**

- .1 Provide performance rating data, certified by an accredited test laboratory and supported by calculations and verified by test results in accordance with referenced standards as follows:
  - .1 Silencer: insertion loss, pressure drop at design conditions, generated noise level.
  - .2 Acoustic plenums: transmission loss and acoustical absorption.

**Part 2 Products**

**2.1 ABSORPTION AND INSULATING MEDIA**

- .1 Acoustical performance measurements to be made in accordance with ASTM E477, ASTM E90 and ASTM C423, except where specified otherwise.
- .2 Acoustic quality, glass fibre, free of shot and odor; bacteria and fungus resistant; free of corrosion causing or accelerating agents; packed to density to meet performance requirements; and meet NBC fire requirements or requirements of authority having jurisdiction for duct lining.

## **2.2 ACOUSTIC SOUND PLENUMS**

- .1 Panels: 50 mm thick tongue and groove connection type, designed for individual panel removal for equipment access without major dismantling of plenum.
  - .1 Outer sheet: 1.3 mm (18 gauge) thick galvanized steel to ASTM A526/A526M, with coating designation Z90.
  - .2 Inner sheet: 0.085 mm (4 mil) thick galvanized steel to ASTM A526/A526M, with coating designation Z90 with 2 mm (79 mil) diameter clean cut perforations on 5 mm (3/16") staggered centres.
  - .3 Fully framed with 1.3 mm (18 gauge) thick galvanized steel channels.
  - .4 Horizontal stiffeners: 0.85 mm (22 gauge) minimum galvanized steel on 800 mm (32") centres to control media settlement.
  - .5 Deflection: not to exceed 1/240 of unsupported panel span at design pressure differential of 2500 Pa (10" w.c.).
  - .6 Connections: as per manufacturers requirements.
- .2 Assembly:
  - .1 Panel and flashing joints externally sealed with 6 mm (1/4") diameter bead of non sag, non hardening sealant. Floor channel to floor connection sealed with 3 mm x 15 mm (1/8" x 1/2") monolastomeric tape.
  - .2 Factory cut and frame openings where greatest dimension exceeds 300 mm (12"). Smaller panel openings, to be site located and cut 50 mm (2") larger in diameter, sleeved with 0.7 mm (22 gauge) minimum galvanized steel.
  - .3 Fill space between pipe or conduit and sleeve with acoustic media, covered and mastic sealed in accordance with manufacturer's instructions.
  - .4 No sensory leakage at design pressure differential of 1000 KPa (145 psi).
  - .5 Assembly RSI not less than 1.2 m<sup>2</sup>C/W (6.81 ft<sup>2</sup>F/Btuh) at 10°C (50°F).
- .3 Acceptable materials:
  - .1 BVA Systems
  - .2 Vibron
  - .3 VAW Systems
  - .4 IAC Acoustics

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install in accordance with manufacturer's instructions.
- .2 Noise flanking: where indicated, install in wall sleeve with uniform clearance all around to ensure no contact of silencer with wall sleeve. Pack with flexible, non hardening caulking on both sides of sleeves.
- .3 Instrument test ports: install at inlet and outlet to permit measurement of insertion loss and pressure loss.

- .4 Suspension: to manufacturer's instructions.

### **3.2 SITE VISIT**

- .1 Supplier of equipment to visit site to ensure installation is in accordance with manufacturer's instructions and submit report to Consultant
- .2 Make adjustments and corrections in accordance with written report.
- .3 Provide Consultant with notice 48h in advance of visit.

### **3.3 TESTING**

- .1 Experienced and competent sound and vibration testing professional engineer to take sound measurement after start up and testing, adjusting and balancing of systems to Testing Adjusting and Balancing (TAB) of Mechanical Systems section.
- .2 Sound measurements to extend over specified frequency range of 250 to 2000 and to be taken:
  - .1 Upstream and downstream of each silencer and plenum.
  - .2 In areas adjacent to mechanical equipment rooms, duct and pipe shafts.
  - .3 At 1800 mm (72") above floor adjacent to first air terminal.
- .3 Provide Consultant with notice 48 h in advance of commencement of tests.
- .4 Establish adequacy of equipment isolation, acceptability of noise levels in occupied areas, other conditions affecting acoustics and, where appropriate, recommendation for remedial measures and costs.
- .5 Submit complete report of test results including sound curves.

**END OF SECTION**

---

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 SMACNA HVAC Duct Construction Standards, Metal and Flexible.
- .3 ANSI/NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems.
- .4 ANSI/NFPA 96, Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .5 CSA B228.1, Pipes, Ducts and Fittings for Residential Type Air Conditioning.

**1.2            PRODUCT DATA**

- .1 Submit product data in accordance with general requirements.
- .2 Indicate the following:
  - .1 Flexible connections.
  - .2 Duct access doors.
  - .3 Turning vanes.
  - .4 Instrument test ports.

**1.3            CERTIFICATION OF RATINGS**

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

**Part 2            Products**

**2.1            GENERAL**

- .1 Manufacture in accordance with CSA B228.1.

**2.2            FLEXIBLE CONNECTIONS**

- .1 Frame: galvanized sheet metal frame with fabric clenched by means of double locked seams.
- .2 Material:
  - .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at -40°C (-40°F) to plus 90°C (194°F), density of 1.3 kg/m.

**2.3            ACCESS DOORS IN DUCTS**

- .1 Non-insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm (25 gauge) thick complete with sheet metal angle frame.

- .2 Insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm (24 gauge) thick complete with sheet metal angle frame and 25 mm (1") thick rigid glass fibre insulation.
- .3 Gaskets: neoprene
- .4 Hardware:
  - .1 Up to 300 mm (12"): 2 sash locks
  - .2 301 mm to 450 mm (13" to 18"): 4 sash locks Complete with safety chain.
  - .3 451 mm to 1000 mm (19" to 40"): piano hinge and minimum 2 sash locks.
  - .4 Doors over 1000 mm (40"): piano hinge and 2 handles operable from both sides.
  - .5 Hold open devices.
- .5 Acceptable materials:
  - .1 Nailor
  - .2 E. H. Price
  - .3 Titus

## **2.4 TURNING VANES**

- .1 Factory or shop fabricated double thickness, to recommendations of SMACNA and as indicated.
- .2 Acceptable materials:
  - .1 Duro Dyne
  - .2 Ductmate

## **2.5 INSTRUMENT TEST PORTS**

- .1 1.6 mm (16 gauge) thick steel zinc plated after manufacture.
- .2 Cam lock handles with neoprene expansion plug and handle chain.
- .3 28 mm (1 1/8") minimum inside diameter. Length to suit insulation thickness.
- .4 Neoprene mounting gasket.
- .5 Acceptable material:
  - .1 Duro Dyne IP1 or IP2
  - .2 Duct mate

## **2.6 PREFABRICATED ROOF CURB**

- .1 Construction: welded with exposed joints ground flush and smooth.
- .2 Material: 1.3 mm (18 gauge) galvanized steel with raised cant and wood nailer.
- .3 25 mm (1") insulation 3 lb density.
- .4 Acceptable materials:
  - .1 Greenheck GPR – 600 mm (24") high
  - .2 Penn

## **2.7 SPIN-IN COLLAR**

- .1 Construction: galvanized straight or conical spin-in collar complete with spin-in bead and crimped collar connection.
- .2 Provide balancing damper where indicated.
- .3 Acceptable materials:
  - .1 Ecco Manufacturing
  - .2 Flex Master

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Flexible connections:
  - .1 Install in following locations:
    - .1 Inlets and outlets to supply air units and fans. (Unless internally isolated)
    - .2 Inlets and outlets of exhaust and return air fans.
    - .3 As indicated.
  - .2 Length of connection: 100 mm (4").
  - .3 Minimum distance between metal parts when system in operation: 75 mm (3").
  - .4 Install in accordance with recommendations of SMACNA.
  - .5 When fan is running:
    - .1 Ducting on each side of flexible connection to be in alignment.
    - .2 Ensure slack material in flexible connection.
- .2 Access doors and viewing panels:
  - .1 Size:
    - .1 600 mm x 600 mm (24" x 24") for person size entry.
    - .2 600 mm x 1000 mm (24" x 40") for servicing entry.
    - .3 300 mm x 300 mm (12" x 12") for viewing.
    - .4 As indicated.
  - .2 Location:
    - .1 At fire and smoke dampers.
    - .2 At control dampers.
    - .3 At devices requiring maintenance.
    - .4 At locations required by code.
    - .5 At inlet and outlet of reheat coils.
    - .6 Elsewhere as indicated.
    - .7 Inlet and outlet of duct mounted coils.

- .3 Instrument test ports.
  - .1 General:
    - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
    - .2 Locate to permit easy manipulation of instruments
    - .3 Install insulation port extensions as required.
    - .4 Locations.
      - .1 For traverse readings:
        - .1 At ducted inlets to roof and wall exhausters.
        - .2 At inlets and outlets of other fan systems.
        - .3 At main and sub-main ducts.
        - .4 And as indicated.
      - .2 For temperature readings:
        - .1 At outside air intakes.
        - .2 In mixed air applications in locations as approved by Consultant.
        - .3 At inlet and outlet of coils.
        - .4 Downstream of junctions of two converging air streams of different temperatures.
        - .5 And as indicated.
- .4 Turning vanes:
  - .1 Install in accordance with recommendations of SMACNA and as indicated.
  - .2 Install on supply ducts only.

### **3.2 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**



**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 SMACNA HVAC Duct Construction Standards, Metal and Flexible.

**1.2            PRODUCT DATA**

- .1 Submit product data in accordance with general requirements
- .2 Indicate the following: performance data.

**Part 2            Products**

**2.1            GENERAL**

- .1 Manufacture to SMACNA standards.

**2.2            SPLITTER DAMPERS**

- .1 Of same material as duct but one sheet metal thickness heavier, with appropriate stiffening.
- .2 Double thickness construction.
- .3 Control rod with locking device and position indicator.
- .4 Rod configuration to prevent end from entering duct.
- .5 Pivot: piano hinge.
- .6 Folded leading edge.

**2.3            SINGLE BLADE DAMPERS**

- .1 Of same material as duct, but one sheet metal thickness heavier. V-groove stiffened, minimum 1.6 mm (16 gauge).
- .2 Size and configuration to recommendations of SMACNA, except maximum height 100 mm (4").
- .3 Shaft extension to accommodate insulation thickness and locking quadrant.
- .4 Inside and outside nylon end bearings.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.

**2.4            MULTI-BLADED DAMPERS**

- .1 Factory manufactured of material compatible with duct.
- .2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.

- .3 Maximum blade height:
  - .1 50 mm (2") up to 375 mm (15") high duct.
  - .2 100 mm (4") max 400 mm (16") high duct and over.
- .4 Bearings: self-lubricating nylon.
- .5 Linkage: shaft extension with locking quadrant.
- .6 Channel frame of same material as adjacent duct, complete with angle stop.
- .7 Shaft extension to accommodate insulation thickness and locking quadrants.**
- .8 Acceptable materials:
  - .1 Duro Dyne
  - .2 E.H. Price
  - .3 Nailor
  - .4 T.A. Morrison
  - .5 Tamco
  - .6 Ruskin
  - .7 Ventex/Alumavent
  - .8 United Enertech

## 2.5 LOCKING QUADRANTS

- .1 6 mm (1/4") dial regulator with square bearing shaft.
  - .1 18 gauge oval frame, cadmium plated, clearly shows damper position.
  - .2 18 gauge formed handle for easy adjustment.
  - .3 Bolt and wing nut lock damper securely.
  - .4 Offset mounting holes avoid interference with damper movement and mechanical fastening to duct.
- .2 9 mm (3/8") and larger: clamp quadrant with square bearing shaft.
  - .1 Accommodates and securely locks square rod, bearing fitting and adaptor pins.
  - .2 Heavily ribbed 16 gauge steel frame, 3 mm (1/8") thick formed steel handle, cadmium-plated.
  - .3 By tightening nut, bearing is securely locked in handle, preventing slippage and rattle.
  - .4 Neoprene and steel washer assembly seals bearing opening to eliminate air-leakage.
  - .5 Screw holes for mechanically fastening to ductwork.
- .3 High pressure system locking quadrant:
  - .1 Airtight, rattle-proof regulator, designed for ZERO leakage at high pressure. Use for applications up to 500°F constant temperature.
  - .2 Handle design for easy recognition of damper position.

- .3 Heavy-gauge, zinc-plated steel, 2 high temperature rubber seals and washers, end bearing support, and 2 end bearings. Pressure loss and damper rattle in ductwork has been a constant annoyance for as long as HVAC ductwork has been installed. Now, a truly air-tight, rattle-proof regulator is available. The SPEC-SEAL regulator utilizes a special high-temperature rubber seal to eliminate leakage and rattle even at many times the pressure found in high pressure.
- .4 Soft, comfortable grip handle with a highly-visible, plastic cover which indicates the damper position.
- .5 Handle to accommodate 9 mm (3/8") or 12 mm (1/2") to match damper shaft size, square and round bearing shafts.
- .4 Acceptable manufacturers:
  - .1 Duro Dyne
  - .2 Ductmate
  - .3 Pottorff

## **2.6 VOLUME EXTRACTORS**

- .1 Fully adjustable gang operated blade volume extractor.
- .2 Cold rolled steel construction, 25 mm (1") blade spacing with matte black finish.
- .3 Provide Type 1 manual adjusting operating lever.
- .4 Acceptable Material
  - .1 EH Price AE-1
  - .2 Krueger EX8/EX88
  - .3 Or equal approved by consultant

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3 For supply, return and exhaust systems, locate balancing dampers in each branch duct.
  - .1 Single blade dampers up to 200 mm (8").
  - .2 Multi-blade dampers over 200 mm (8").
- .4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.
- .5 All dampers to be vibration free.
- .6 Leave all dampers in open position for T.A.B.
- .7 Fasten locking quadrants to ductwork and shaft.
- .8 Place locking quadrants on standoffs where ductwork insulated.

- .9 Lock down quadrant arm in the open position.

### **3.2 VOLUME EXTRACTOR**

- .1 Install at branch take off connections where indicated.
- .2 Secure lever adjustment rod to inside duct collar after final adjustments.

### **3.3 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ANSI/NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
- .3 CAN/ULC-S112, Standard Method of Fire Test of Fire Damper Assemblies.
- .4 CAN/ULC-S112.1, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies.
- .5 ULC-S505, Fusible Links for Fire Protection Service.

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with general requirements.
- .2 Indicate the following:
  - .1 Fire dampers.
  - .2 Operators.
  - .3 Firestop flaps.
  - .4 Fusible links.

**1.3 MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.

**1.4 MAINTENANCE MATERIALS**

- .1 Provide following:
  - .1 Six (6) fusible links of each type.

**1.5 CERTIFICATION OF RATINGS**

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

**Part 2 Products**

**2.1 FIRE DAMPERS (DYNAMIC)**

- .1 Multi blade or roll type, fire damper suitable for HVAC system velocities up to 2000 fpm (610 m/mm), dual direction air flow, max 4" wg pressure.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
- .3 Top hinged: offset single damper, round or square; multi-blade hinged or interlocking type; guillotine type; sized to maintain full duct cross section.

- .4 Stainless closure spring to positively close damper upon fusible link release, for horizontal or vertical orientations.
- .5 Linkage concealed in frame.
- .6 40 mm x 40 mm x 3 mm (1½" x 1½" x 16ga) retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.
- .7 Fire damper assemblies and type to meet requirements of provincial fire authority and authority having jurisdiction.
- .8 Acceptable materials:
  - .1 Ruskin
  - .2 Nailor
  - .3 E.H. Price
  - .4 T.A. Morrison
  - .5 Tamco
  - .6 Greenheck
  - .7 Ventex/Alumavent
  - .8 Pottorff

## **2.2 MULTIBLADE DAMPERS (DYNAMIC OR STATIC)**

- .1 Provide and install multiblade dampers where roll type fire dampers do not have a ULC listing for the size of the penetration through the assembly.
- .2 Multi blade type fire dampers shall be suitable for HVAC system velocities up to 2000 fpm (610 m/min), dual direction air flow, max 4" wg pressure.
- .3 Damper shall be labelled for dynamic or static systems as appropriate for the installed location.
- .4 Frame shall be constructed on 16 ga (1.6) steel hat channel with mitered corners reinforced with die-formed corner gussets for strength.
- .5 Damper blades shall be 14 ga (2.0) equivalent steel formed double skin, airfoil design.
- .6 Damper shall be of opposed blade configuration with an interlocking blade design. Blade seals are not acceptable.
- .7 Blade axels shall be double bolted at each end of the blade to provide positive locking connection.
- .8 Bearings shall be sintered stainless steel type.
- .9 Blade linkage shall be zero-maintenance, concealed in frame and out of the air stream.
- .10 Each damper shall be complete with a UL listed fusible link that will cause the damper to close and lock in closed position by means of an over centre/knee lock linkage for assured closure.
- .11 Each damper shall be provided with an internal manual locking quadrant(s) for setting and locking of blades in desired position.

- .12 Provide a steel sleeve of appropriate gauge and length for the assembly being penetrated.
- .13 Provide a 40 mm x 40 mm x 3 mm (1½" x 1½" x 16ga) retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.
- .14 Fire damper assemblies and type to meet requirements of provincial fire authority and authority having jurisdiction.
- .15 Acceptable materials:
  - .1 Ruskin
  - .2 Nailor
  - .3 E.H. Price
  - .4 T.A. Morrison
  - .5 Tamco
  - .6 Greenheck
  - .7 Ventex/Alumavent
  - .8 Pottorff

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 Provide where indicated and at all fire rated partitions indicated, on architectural drawing.
- .2 Install in accordance with ANSI/NFPA 90A and in accordance with conditions of ULC listing.
- .3 Maintain integrity of fire separation.
- .4 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.
- .5 Install access door adjacent to each damper.
- .6 Coordinate with installer of firestopping.
- .7 Static fire dampers: Only on transfer air ducts where ductwork is not connected to a fan/blower.
- .8 Dynamic fire dampers: In all duct work where air is moved by a fan/blower.

#### **3.2 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.

- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**



**Part 1            General**

**1.1            CODES AND STANDARDS**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ANSI/NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
- .3 CAN/ULC-S112, Standard Method of Fire Test of Fire Damper Assemblies.
- .4 CAN/ULC-S112.1, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies.
- .5 ULC-S505, Fusible Links for Fire Protection Service.
- .6 CAN/ULC-S524, Installation of Fire Alarm Systems
- .7 CAN/ULC-S1001.11, Integrated Systems Testing of Fire Protection and Life Safety Systems.

**1.2            PRODUCT DATA**

- .1 Submit product data in accordance with general requirements indicating the following:
  - .1 Damper type
  - .2 Operators
  - .3 Fusible links
  - .4 Smoke detectors
  - .5 Power requirements
  - .6 Size, orientation, construction

**1.3            MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.

**1.4            MAINTENANCE MATERIALS**

- .1 Provide following:
  - .1 Six (6) fusible links of each type.

**1.5            CERTIFICATION OF RATINGS**

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

---

**Part 2            Products**

**2.1            SMOKE DAMPERS**

- .1 Provide a complete system, consisting of the damper, damper actuator, smoke detector with duct sample tube, sleeve and all other components necessary for a complete and operable system. **The assembly shall be factory assembled as a single unit.** Field assembly shall be permitted at contractor discretion provided all listings are maintained and the installation follows all manufacturer installation guidelines.
- .2 Damper
  - .1 Damper shall be ULC listed and labelled
  - .2 Both damper and damper actuator to be ULC listed and labelled.
  - .3 Normally closed smoke/seal: folding blade type. Blade edge seals of flexible stainless steel shall provide required constant sealing pressure. Stainless steel negator springs with locking devices shall ensure positive closure for units.
  - .4 Damper shall have Class I leakage rating.
  - .5 Suitable for horizontal or vertical installations.
  - .6 Damper Material: Damper material shall match ductwork it is installed in (i.e., stainless steel in laboratory). Refer to specification section 23 31 13 Metal Ducts.
- .3 Actuator
  - .1 Actuator shall be ULC listed and labelled
  - .2 Motorized actuator: 2-position, spring return, normally open with power on. When power is interrupted damper shall close automatically. Upon return of power, damper shall automatically reset open. Actuators are to be located outside of airstream, unless otherwise specified or shown on drawings.
  - .3 Exterior visualization of damper position.
  - .4 Damper actuator end switches for monitoring damper position by the BAS.
- .4 Factory sleeve.
  - .1 Type and style: matching application.
- .5 Operating Temperature: 0° Celsius to 99° Celsius ambient temperature rating for 300 fpm to 4000 fpm air velocity.
- .6 Smoke Detector:
  - .1 ULC approved photoelectric duct smoke detector;
  - .2 Operates from 300 to 3000 ft/min air velocity (fan system), -4 to 158°F temperature, and 0 to 95% non-condensing humidity;
  - .3 Operates from 100 to 4000 ft/min air velocity, -4 to 158°F temperature and 0 – 95% non-condensing humidity (transfer ducts)
  - .4 test/reset button with LED display;
  - .5 The detector housing shall be ULC listed specifically for use in air handling systems; capable of local testing via magnetic switch and test button; duct mounted smoke detector with sampling tube, housing.

- .6 The detector shall incorporate separate 2.0A 30VDC Alarm and Supervisory contacts. Alarm contacts shall be normally open (N.O.) in which closed contacts will indicate an alarm condition to the fire alarm panel. Supervisory contacts shall be normally closed (N.C.) in which open contacts will indicate a trouble condition to the fire alarm panel.
- .7 Damper assembly to operate at 120V with single point power connection.
- .8 Large damper sizes can be provided in multiple sections. Field assembly is acceptable following manufacturer's installation guidelines.
- .9 Size: as indicated on drawings.
- .10 Detectors and electrical components within the airstream shall be classified for use in a Class I, Zone 2 system (as defined by the Electrical Safety Code).
- .11 Acceptable materials:
  - .1 E H Price
  - .2 NCA Ltd.
  - .3 Nailor Industries Inc.
  - .4 Ruskin
  - .5 Alumavent
  - .6 United Enertech
  - .7 Safeair-Dowco (stainless steel)
  - .8 Pottorff

## 2.2 COMBINATION FIRE AND SMOKE DAMPERS

- .1 Provide a complete system, consisting of the damper, damper actuator, smoke detector with duct sampling tube, sleeve and all other components necessary for a complete and operable system. **The assembly shall be factory assembled as a single unit.** Field assembly shall be permitted at contractor discretion provided all listings are maintained and the installation follows all manufacturer installation guidelines.
- .2 Damper
  - .1 Damper shall be ULC listed and labelled
  - .2 Both damper and damper actuator to be ULC listed and labelled.
  - .3 Normally closed smoke/seal: folding blade type. Blade edge seals of flexible stainless steel shall provide required constant sealing pressure. Stainless steel negator springs with locking devices shall ensure positive closure for units.
  - .4 Damper shall have Class I leakage rating.
  - .5 Suitable for horizontal or vertical installations.
  - .6 Damper Material: Damper material shall match ductwork it is installed in (i.e., stainless steel in laboratory). Refer to specification section 23 31 13 Metal Ducts.
- .3 Actuator/Link
  - .1 Actuator shall be ULC listed and labelled

- .2 Motorized actuator: 2-position, spring return, normally open with power on. When power is interrupted damper shall close automatically. Upon return of power, damper shall automatically reset open. Actuators are to be located outside of airstream, unless otherwise specified or shown on drawings.
- .3 Exterior visualization of damper position.
- .4 Damper actuator end switches for monitoring damper position by the BAS.
- .5 Combined actuator: electrical control system actuated from smoke sensor or smoke detection system and from fusible link.
- .6 Fusible link, or electric re-settable link (ERL).
- .7 Electric fire sensor capable of remote openable control is to be provided in place of fusible link where specifically indicated in project documents.
- .8 Where ERL or electric fire sensor is used in place of fusible link, this device shall fail closed upon power failure.
- .4 Factory sleeve.
  - .1 Type and style: matching application.
- .5 Operating Temperature: 0° Celsius to 99° Celsius ambient temperature rating for 300 fpm to 4000 fpm air velocity.
- .6 Smoke Detector:
  - .1 ULC approved photoelectric duct smoke detector;
  - .2 Operates from 300 to 3000 ft/min air velocity (fan systems), -4 to 158°F temperature, and 0 to 95% non-condensing humidity;
  - .3 Operates from 100 to 4000 ft/min air velocity, -4 to 158°F temperature and 0 – 95% non-condensing humidity (transfer ducts)
  - .4 Test/reset button with LED display;
  - .5 The detector housing shall be ULC listed specifically for use in air handling systems; capable of local testing via magnetic switch and test button; duct mounted smoke detector with sampling tube, housing
  - .6 The detector shall incorporate separate 2.0A 30VDC Alarm and Supervisory contacts. Alarm contacts shall be normally open (N.O.) in which closed contacts will indicate an alarm condition to the fire alarm panel. Supervisory contacts shall be normally closed (N.C.) in which open contacts will indicate a trouble condition to the fire alarm panel.
- .7 Damper assembly to operate at 120V with single point power connection.
- .8 Large damper sizes can be provided in multiple sections. Field assembly is acceptable following manufacturer's installation guidelines.
- .9 Fire rating to match wall assembly i.e. 1 hour/1 ½ hour/2 hour/ 3 hour.
- .10 Size: as indicated on drawings.
- .11 Detectors and electrical components within the airstream shall be classified for use in a Class I, Zone 2 system (as defined by the Electrical Safety Code).

- .12 Acceptable materials:
  - .1 E H Price
  - .2 NCA Ltd.
  - .3 Nailor Industries Inc.
  - .4 Ruskin
  - .5 Alumavent
  - .6 United Enertech
  - .7 Pottorff
  - .8 Safeair-Dowco (stainless steel)
  - .9 Pottorff

## **2.3 NUMBER OF AIR TYPE SMOKE DETECTORS**

- .1 Where air velocities are greater than 1.5 m/s (300 feet per second), one air duct type detector shall be installed for every 1.5 meters square (16 square feet) of cross-sectional duct area.
- .2 Where air velocities are less than 1.5 m/s (300 feet per second), one duct type smoke detector shall be installed for every 0.5 meters square (5.3 square feet) or cross-sectional duct area.

## **2.4 PRESSURE RELIEF DOORS**

- .1 Frames shall be Z-shape, 12 gage (2.8) galvanized steel.
- .2 Door shall be 12 gage (2.8) galvanized steel, hinged on one side.
- .3 Seal shall be around the door perimeter allowing no more than 7 cfm/ft<sup>2</sup> at 1.0 inch w.g..
- .4 Door shall include stainless steel springs to close door upon pressure relief and system shutdown.
- .5 All release mechanisms, springs and parts shall be completely out of airstream.
- .6 Pressure relief settings available from 2" (0.5 kPa) to 10" (2.49 kPa) increments of 1" w.g. (0.25 kPa). Supplier shall examine plans to provide appropriate pressure relief based on associated air handling system.
- .7 Pressure relief mechanism shall be factory calibrated in an AMCA Registered Laboratory.
- .8 Pressure Relief Doors shall be provided as indicated in the execution section.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Provide smoke dampers where indicated and at all duct penetrations through smoke barrier partitions indicated on architectural drawings.

- .2 Provide combination fire and smoke dampers where indicated and at all duct penetrations through fire rated smoke barrier partitions indicated on architectural drawings. To provide separated fire dampers and smoke dampers, obtain approval from the consultant for the alternate arrangement.
- .3 Provide pressure relief doors (both positive and negative as applicable) as follows:
  - .1 For all systems with a combination fire smoke or smoke damper in the duct main of the system when:
    - .1 The system operates at static pressure of 1.0 inches w.g. or higher; and
    - .2 More than 50% of the system airflow passes through the combination fire/smoke or smoke damper.
  - .2 Where/as indicated on the plans.
- .4 Install in accordance with ANSI/NFPA 90A, in accordance with conditions of ULC listing and manufacturer's recommendation.
- .5 Maintain integrity of smoke separation and fire rating.
- .6 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.
- .7 Install access door adjacent to each damper and smoke detector.
- .8 Front grille access for through wall dampers that terminate in a grille is acceptable.
- .9 Provide proper firestopping and duct seal to fire barrier wall.
- .10 Confirm proper operation and test sheets.
- .11 Should contractor provide separated devices mount smoke detector downstream of damper and within 1.5 m (5 ft) of damper.
- .12 Ensure access doors/panels, fusible links, damper actuators and sensors are easily observed and accessible.

### **3.2 PROTECTION**

- .1 Contractor is to ensure all fire smoke dampers detectors are protected from dust, dirt, humidity, and water at all times during construction. This applies to detectors installed, stored on site or stored in storage containers. Contractor shall seal all open-ended ductwork on site at all times. Failure to properly protect dampers, ductwork and detectors will result in the Contractor cleaning all dampers and ductwork. Any detectors that are damaged or dirty shall be replaced at the contractor's expense.

### **3.3 CLEANING**

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

### **3.4 INTEGRATED LIFE SAFETY SYSTEMS TESTING**

- .1 Prior to the building Integrated Life Safety Systems Testing the mechanical contractor shall commission/verify the operation of all installed smoke dampers.

- .2 Participate in the Integrated Life Safety Systems Testing to confirm proper operation of all operating smoke dampers and associated Life Safety Systems (i.e. fire alarm).
- .3 This contractor shall work with the Integrated Life Safety Contractor and reset all systems back into proper operation.
- .4 Include all costs associated with participation Integrated Life Safety System Testing in the tender value.

### **3.5 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**

**Part 1            General**

**1.1            GENERAL**

- .1        This section applies to operating dampers not specified in Controls Section.

**1.2            REFERENCES**

- .1        All codes, standards, etc. as referenced shall be the latest edition.
- .2        ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

**1.3            PRODUCT DATA**

- .1        Submit product data in accordance with general requirements.
- .2        Indicate the following:
  - .1        Performance data.

**1.4            MAINTENANCE DATA**

- .1        Provide maintenance data for incorporation into manual specified in general requirements.

**1.5            CERTIFICATION OF RATINGS**

- .1        Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency.

**Part 2           Products**

**2.1            MOTORIZED DAMPERS**

- .1        Opposed blade type.
- .2        Extruded aluminum, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, extruded aluminum frame.
- .3        Pressure fit self-lubricated bronze bearings.
- .4        Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.
- .5        Operator: Refer to BAS Section.
- .6        Performance:
  - .1        Leakage: in closed position to be less than 2% of rated air flow at 250 Pa (1" w.c.) differential across damper.
  - .2        Pressure drop: at full open position to be less than 10 Pa (0.04" w.c.) differential across damper.



- .7 Insulated aluminum dampers:
  - .1 Frames: insulated with extruded polystyrene foam with R factor of 5.0.
  - .2 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, R factor of 5.0.
  - .3 Use on services to the exterior.
  - .4 Acceptable materials:
    - .1 Honeywell
    - .2 Johnson
    - .3 T. A. Morrison
    - .4 E.H. Price
    - .5 Tamco
    - .6 Ruskin
    - .7 Nailor
    - .8 Henderson Industrial
    - .9 Ventex/Alumavent
    - .10 Pottorff

## **2.2 DISC TYPE DAMPERS**

- .1 Frame: brake formed, welded, 1.6 mm (16 gauge) thick, Type Z90 galvanized steel to ASTM A653/A653M.
- .2 Disc: spin formed, 1.6 mm (16 gauge) thick, Type Z90 galvanized steel to ASTM A653/A653M.
- .3 Gasket: extruded neoprene, field replaceable.
- .4 Bearings: roller self lubricated and sealed.
- .5 Operator: compatible with damper, linear stroke operator, spring loaded actuator, zinc-aluminum foundry alloy casting cam follower.
- .6 Performance:
  - .1 Leakage: in closed position to be less than 0.001% of rated air flow at 100 kPa (15 psi) pressure differential across damper.
  - .2 Pressure drop: at full open position to be less than 100 kPa (15 psi) differential across damper.
- .7 Acceptable material:
  - .1 Duro Dyne
  - .2 Henderson Industrial
  - .3 Pottorff

## **2.3 BACK DRAFT DAMPERS**

- .1 Automatic gravity operated, multi leaf, aluminum construction with nylon bearings, centre pivoted or counterweighted, as indicated.

- .2 Acceptable materials:
  - .1 T.A. Morrison
  - .2 Tamco Series 7000
  - .3 Ruskin
  - .4 Nailor
  - .5 E.H. Price
  - .6 Henderson Industrial
  - .7 Ventex/Alumavent
  - .8 Pottorff

## **2.4 RELIEF DAMPERS**

- .1 Automatic multi-leaf aluminum dampers with ball bearing centre pivoted and counter-weights set to open at 100 Pa (0.4" w.c.) static pressure, (adjustable).
- .2 Acceptable material:
  - .1 T. A. Morrison
  - .2 Henderson Industrial
  - .3 Ventex/Alumavent
  - .4 Pottorff

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Seal multiple damper modules with silicon sealant.
- .4 Install access door adjacent to each damper. See Duct Accessories Section.
- .5 Insulated dampers on all outside air intake and exhaust damper.
- .6 Non-insulated dampers on all interior motorized dampers not exposed to outside air.

### **3.2 ELECTRICAL ROOM DAMPER OPERATION**

- .1 Outdoor air damper modulates open on increase of room temperature above 80°F.
- .2 When damper is fully open end switch start exhaust fan.
- .3 When temperature reaches below setpoint damper is closed and exhaust fan off.

### **3.3 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.

- .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
  - .2 Disk type dampers gasket: Ten (10) years warranty.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 CAN/ULC-S110, Standard Methods of Test for Air Ducts.
- .3 UL 181, Factory Made Air Ducts and Air Connectors.
- .4 ANSI/NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
- .5 ANSI/NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems.
- .6 SMACNA HVAC Duct Construction Standards - Metal and Flexible.

**1.2                PRODUCT DATA**

- .1 Submit product data in accordance with general requirements.
- .2 Indicate the following:
  - .1 Thermal properties.
  - .2 Friction loss.
  - .3 Acoustical loss.
  - .4 Leakage.
  - .5 Fire rating.

**1.3                CERTIFICATION OF RATINGS**

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

**Part 2            Products**

**2.1                GENERAL**

- .1 Factory fabricated to CAN/ULC S110.
- .2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.
- .3 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

**2.2                METALLIC –INSULATED**

- .1 Spiral wound flexible aluminum with factory applied, 25 mm (1") thick flexible glass fibre thermal insulation with vapour barrier and vinyl jacket, Class 1 duct material.
- .2 Performance:
  - .1 Factory tested to 2.5 kPa (10" w.c.) without leakage.
  - .2 Maximum relative pressure drop coefficient: 3.

- .3      Operating pressure: 300 mm (12").
- .3      Acceptable materials:
  - .1      Flexmaster T/L – VT
  - .2      Ductmate

**Part 3            Execution**

**3.1                DUCT INSTALLATION**

- .1      Install in accordance with: SMACNA.
- .2      Maximum length of flexible duct: 1.8 m (6' 0").
- .3      Minimum length of acoustical ductwork; 1.5 m (5' 0") with minimum of 1 bend.
- .4      Provide support at centre of flexible duct with 25 mm (1") wide galvanized hanger.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 SMACNA HVAC Duct Construction Standards, Metal and Flexible.
- .3 ASTM C1071 Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- .4 ASTM C916 Standard Specification for Adhesive for Duct Thermal Insulation.
- .5 ANSI/NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
- .6 ANSI/NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems.
- .7 **ASTM C177, Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.**
- .8 **CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.**

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with general requirements.

**Part 2 Products**

**2.1 RECTANGULAR/SQUARE DUCT LINER**

- .1 General:
  - .1 Acoustical duct liner to be fibreglass duct liner meeting or exceeding requirements of ASTM C1071, Type I, Flexible or Type II, Rigid, and NFPA 90A/90B.
  - .2 Bonded with formaldehyde free bio-based binder
  - .3 Mat faced airstream surface
  - .4 Factory applied edge coating
  - .5 Shall not contain formaldehyde, PBDE's, asbestos, mercury, mercury compounds, lead, contain 50% or greater recycled glass content.
  - .6 Thermal conductivity, ASTM C177/C518/C1114 .24BTU (sf•hr•°F) @ 75°F mean temp).
  - .7 Noise Reduction Coefficient (NRC) 1.5 PCF 1" = .70, 1 ½ " = .80, 2" =.95  
ASTM C423, Type A mounting.
  - .8 Noise Reduction Coefficient (NRC) 2.0 PCF 1/2" = .50, 1" = .70, 1 ½ " = .85  
ASTM C423, Type A mounting
  - .9 Corrosiveness/corrosion, ASTM C665/C1617. Does not accelerate/pass.
  - .10 Mold and mildew growth/fungi resistance, ASTM C1338, ASTM G21/G22, UL2824. Pass/resistant to mold.

- .11 Maximum service temperature, ASTM C411, 250°F (121°C).
- .12 Maximum rate air velocity, ASTM C1071, 6,000 ft./min. (30.5 m/sec.)
- .13 Water vapor sorption, ASTM C1104, less than 3%.
- .14 Surface burning characteristics, ASTM E84, UL 273, CAN/ULC S102, 20/50 flame spread/smoke development.
- .15 Acceptable material:
  - .1 Knauf Atmosphere Duct Liner
  - .2 Manson
  - .3 Johns Manville
  - .4 Owen Corning
- .2 Rigid:
  - .1 Use on flat surfaces.
  - .2 25 mm (1") thick, to CGSB 51-GP-10M, fibrous glass rigid board duct liner.
  - .3 Density: 96 kg/m<sup>3</sup> (6 lb/ft<sup>3</sup>).

## **2.2 FLEXIBLE/ROUND ACOUSTIC DUCT LINER**

- .1 **General:**
  - .1 Acoustical duct liner to be fibreglass duct liner meeting or exceeding requirements of ASTM C1071, Type I, Flexible, and NFPA 90A/90B.
  - .2 Liner to have factor made, evenly spaced kerfs to allow material to conform to interior of round duct.
  - .3 Bonded with formaldehyde free bio-based binder
  - .4 Airstream Surface protected by acrylic coating.
  - .5 Factory applied edge coating
  - .6 Shall not contain formaldehyde, PBDE's, asbestos, mercury, mercury compounds, lead, contain 50% or greater recycled glass content.
  - .7 Thermal conductivity, ASTM C177/C518/C1114 0.23 BTU (sf•hr•°F) @ 75°F mean temp).
  - .8 Noise Reduction Coefficient (NRC) 1" = 0.75, 1 ½ " = 0.85, 2" = 0.95  
ASTM C423, Type A mounting.
  - .9 Mold and mildew growth/fungi resistance, ASTM C1338, ASTM G21/G22, UL2824. Pass/resistant to mold.
  - .10 Maximum service temperature, ASTM C411, 250°F (121°C).
  - .11 Maximum rate air velocity, ASTM C1071, 6,000 ft./min. (30.5 m/sec.)
  - .12 Water vapor sorption, ASTM C1104, less than 3%.
  - .13 Surface burning characteristics, ASTM E84, UL 273, CAN/ULC S102, 20/50 flame spread/smoke development.

**.14 Acceptable material:**

- .1 Johns Manville Spiracoustic**
- .2 Knauf**
- .3 Manson**
- .4 Owen Corning**

**.2 Flexible:**

- .1 Use on round or oval surfaces only.**
- .2 25 mm (1") thick, to ASTM C1071, fibrous glass blanket duct liner.**
- .3 Density: 64 kg/m<sup>3</sup> (4.0 lb/ft<sup>3</sup>).**

**2.3 ADHESIVE**

- .1 Meet requirements of ASTM C916.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range -29°C (-20°F) to 93°C (200°F).
- .3 Acceptable material:
  - .1 Duro Dyne 1A-22
  - .2 Ductmate

**2.4 FASTENERS**

- .1 Weld pins 2.0 mm (14 gauge) diameter, length to suit thickness of insulation. Metal retaining clips, 32 mm (1¼") square.
- .2 Acceptable material:
  - .1 Duro Dyne
  - .2 Ductmate

**2.5 JOINT TAPE**

- .1 Poly-Vinyl treated open weave fiberglass membrane 50 mm (2") wide.
- .2 Acceptable materials:
  - .1 Duro Dyne FT2
  - .2 Ductmate

**2.6 SEALER**

- .1 Meet requirements of ANSI/NFPA 90A and ANSI/NFPA 90B.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range -68°C (-90°F) to 93°C (200°F).
- .3 Acceptable materials:
  - .1 Duro Dyne 1A-94
  - .2 Ductmate



**Part 3            Execution**

**3.1                GENERAL**

- .1      Do work in accordance with recommendations of MAIMA Fibrous Glass Duct Liner Standards (FGDLS) or SMACNA duct liner standards.
- .2      Line inside of ducts where indicated.
- .3      Duct dimensions, as indicated, are clear inside duct lining.
- .4      Provide an interior of ductwork from fans from minimum distance of 3 m (10'-0").

**3.2                DUCT LINER**

- .1      Install in accordance with manufacturer's recommendations, and as follows:
  - .1          Fasten to interior sheet metal surface with 100% coverage of adhesive.
  - .2          In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 300 mm (12") on centres.
- .2      Weld pins are to have cupped or beveled heads to prevent damage to lining surface.
- .3      Store foam liners away from sunlight.

**3.3                JOINTS**

- .1      Seal all butt joints, exposed edges, weld pin and clip penetrations and all damaged areas of liner with joint tape and sealer. Install joint tape in accordance with manufacturer's recommendations, and as follows:
  - .1          Bed tape in sealer.
  - .2          Apply 2 coats of sealer over tape.
- .2      Replace damaged areas of liner at discretion of Consultant.
- .3      Protect leading and trailing edges of each duct section with sheet metal nosing having 15 mm (1/2") overlap and fastened to duct.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 AMCA 99, Standards Handbook.
- .3 ANSI/AMCA 210, Laboratory Methods of Testing Fans for Certified Aerodynamics Performance Rating.
- .4 AMCA 300, Revised 1987, Reverberant Room Method for Sound Testing of Fans.
- .5 AMCA 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .6 ANSI/ASHRAE 51, Laboratory Methods of Testing Fans for Certified Aerodynamics Performance Rating.
- .7 ANSI/NFPA 96 – Ventilation Control and Fire Protection of Commercial Cooking Operations.

**1.2                SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with general requirements.
- .2 Product data to include fan curves and sound rating data.

**1.3                OPERATION AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data for incorporation into manual specified in general requirements.

**1.4                CERTIFICATION OF RATINGS**

- .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered from independent testing agency signifying adherence to codes and standards in force.
- .2 Provide confirmation of testing.

**Part 2            Products**

**2.1                FANS GENERAL**

- .1 Capacity: flow rate, total static pressure Pa, r/min, W (" w.c., r/min, bhp) model and size and sound ratings as indicated on schedule.
- .2 Statically and dynamically balanced. Constructed in conformity with AMCA 99.
- .3 Sound ratings: comply with AMCA 301, tested to AMCA 300.
- .4 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210, and ANSI/ASHRAE 51.

- .5 Bearings: sealed lifetime of self aligning type with oil retaining, dust excluding seals and a certified minimum rated life of 100,000 h in accordance with AFBMA L10 life standard. Bearings to be rated and selected in accordance with AFBMA 9 and AFBMA 11.
- .6 Provide vibration isolation hangers/pads for all fans.
- .7 Electrical components and motors within the airstream shall be classified for use in a Class I, Zone 2 system (as defined by the Electrical Safety Code) when connected to ductwork systems served by refrigerant containing air handling systems.
- .8 Provide factory mounted speed control for all direct drive motors.
- .9 Acceptable materials:
  - .1 Greenheck
  - .2 Penn-Barry
  - .3 Cook
  - .4 Jenco (S & P)/Jenn
  - .5 Carnes
  - .6 Acme
  - .7 Zonex
  - .8 Nutone (Range hood)
  - .9 Broan (Range hood)
  - .10 Twin-City
  - .11 Reversomatic
  - .12 Fantech
  - .13 Aerovent

## **2.2 CABINET FANS – IN-LINE**

- .1 Fan characteristics and construction: as centrifugal fans.
- .2 Casing floor mounted or cabinet hung single inlet aluminum wheel in factory fabricated casing complete with vibration isolators and seismic control measures, motor, V-belt drive and guard inside or outside casing as indicated.
- .3 Fabricate casing of zinc coated or phosphate treated steel reinforced and braced for rigidity. Provide removable panels for access to interior. Uncoated, steel parts shall be painted over with corrosion resistant paint to CAN/CGSB 1.181. Internally line cabinet with 25 mm (1") thick rigid acoustic insulation, pinned and cemented bell mouth inlet cone.
- .4 Size, type, and capacity: as indicated.

## **2.3 CEILING DISCHARGE FANS**

- .1 Centrifugal direct drive, with plug in type electric motor suitable for ceiling installation, zinc coated rectangular metal housing.
- .2 Sizes and capacity: as indicated.

- .3 Toggle switch operated complete with integral electrical outlet box with plug-in type receptacle.
- .4 Side duct outlet with integral backdraft damper, size as indicated.
- .5 Wall cap complete with spring loaded backdraft damper with neoprene gasket.
- .6 Silver anodized aluminum grille paint finish.

## **2.4 RANGE HOOD EXHAUST FANS**

- .1 Centrifugal direct drive 750 mm (30") wide, suitable for under cabinet installation, enamel steel metal housing complete with halogen lights, colour selected by consultant.
- .2 Sizes and capacity: as indicated.
- .3 Internal Toggle switch operated fan and light.
- .4 Top or rear side 80 mm x 250 mm (3" x 10") rectangular duct outlet with integral backdraft damper.
- .5 Wall cap complete with spring loaded backdraft damper with neoprene gasket.
- .6 Aluminum mesh cleanable grease filter.

## **2.5 EXISTING EXHAUST AIR FANS**

- .1 Refurbish existing exhaust air fans as follows:
  - .1 Vacuum entire unit interior.
  - .2 Lubricate all bearings.
  - .3 Replace fan belt(s).
  - .4 Rebalance to capacity indicated.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install in accordance with manufacturer's instructions.
- .2 Provide flexible duct connection for all fans.
- .3 Provide backdraft damper at building exterior penetration.
- .4 Provide and install vibration isolation.
- .5 Provide and install roof curb for all roof mounted fans.
- .6 Provide and install sleepers for utility set style roof mounted fans; provide roof curb for duct penetration.

### **3.2 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.

- .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**

---

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

**1.2            PRODUCT DATA**

- .1 Submit product data in accordance with general requirements.
- .2 Indicate the following:
  - .1 Performance data.
  - .2 Noise data.
  - .3 Physical dimensions.

**1.3            MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.

**1.4            CERTIFICATION OF RATINGS**

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by an independent testing agency.

**Part 2            Products**

**2.1            VARIABLE AIR VOLUME BOXES**

- .1 Single duct, variable volume air distribution assemblies of the sizes and capacities as shown on the plans.
- .2 **All variable volume air boxes are to be provided in their oversized/large capacity version to limit pressure drop across the heating coil.**
- .3 The assemblies shall be pressure independent and shall reset to any air flow between zero and the maximum catalogued air volume.
- .4 At an inlet velocity of 610 m/min (2,000 fpm), the differential static pressure for any unit with attenuator section, sizes 4 through 16, shall not exceed 25 Pa (0.10" w.c.).
- .5 Sound ratings of air distribution assemblies, shall not exceed 30 NC at 25 Pa (0.10" w.c.) static pressure.
- .6 Pressure shall be ARI Certified.
- .7 The air flow sensor shall be of a cross configuration located at the inlet of the assembly and shall have multiple pickup points, designed to average the flow across the inlet of the assembly. The air flow sensor shall amplify the sensed air flow signal.

- .8 Provide a discharge air temperature sensor on discharge of VAV box. Temperature sensor shall be capable of display on BAS.
- .9 The assembly casing shall be constructed of 0.7 mm (22 gauge) zinc coated steel, internally lined with 20 mm (¾") thick, dual density fiberglass insulation, which complies with UL-181 and NFPA-90A. Any cut edges of fiberglass exposed to the air stream shall be coated with NFPA-90A approved sealant.
- .10 The primary air valve damper shall be heavy gauge metal, with peripheral gasket, pivoted in self-lubricating bearings. In the full closed position, air leakage past the closed damper shall not exceed 2% of the nominal catalogue rating at 750 Pa (3" w.c.) inlet static pressure, as rated by ARI Standard 880.
- .11 Provide 900 mm (36") long discharge sound attenuator for each unit.
- .12 Provide hot water reheat coil mounted in 0.7 mm (22 gauge) galvanized steel housing. Reheat coil to have copper tubes, aluminum fins with O.D. sweat connections, and quick opening cam lock access door. Refer to schedule for reheat coil requirements. Provide minimum 2 row coil.
- .13 DDC controls including controller, flow transducer, electric actuator and protective shroud if required to be provided by controls manufacturer.
- .14 Electrical components and motors within the airstream shall be classified for use in a Class I, Zone 2 system (as defined by the Electrical Safety Code) when connected to ductwork systems served by refrigerant containing air handling systems.
- .15 Terminal unit manufacturer shall factory mount controller and actuator including tubing from cross flow sensor to controls, wiring controller to motor and calibration.
- .16 Size and capacity: as indicated.
- .17 Acceptable materials:
  - .1 E.H. Price **SDV or EH Price SDVLP (Low Profile)**
  - .2 Nailor
  - .3 Titus
  - .4 Krueger
  - .5 Carnes
  - .6 Metalaire

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Install quick opening access door (with sash locks) adjacent to each damper.
- .4 Install controls as per manufacturer's requirements.

- .5 Install with at least 100 mm (4") of flexible inlet ducting.
- .6 Wire associated HVAC unit's refrigeration detection system alarm to all damper actuators and electric reheat coil input signal connection locations.

### **3.2 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
- .1 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**



**Part 1 General**

**1.1 PRODUCT DATA**

- .1 Submit product data in accordance with general requirements.
- .2 Indicate the following:
  - .1 Capacity.
  - .2 Throw and terminal velocity.
  - .3 Noise criteria.
  - .4 Pressure drop.
  - .5 Neck velocity.

**1.2 MAINTENANCE MATERIALS**

- .1 Include:
  - .1 Keys for volume control adjustment.
  - .2 Keys for air flow pattern adjustment.

**1.3 MANUFACTURED ITEMS**

- .1 Grilles, registers, and diffusers of same generic type to be product of one manufacturer.

**1.4 CERTIFICATION OF RATINGS**

- .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by them from independent testing agency signifying adherence to codes and standards.

**Part 2 Products**

**2.1 GENERAL**

- .1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity as indicated.
- .2 Frames:
  - .1 Full perimeter gaskets.
  - .2 Plaster frames where set into plaster or gypsum board and as specified.
  - .3 Concealed fasteners.
- .3 Concealed operators.
- .4 Colour and Finish: standard as directed by Consultant.

.5 Acceptable materials:

- .1 E.H. Price
- .2 Nailor
- .3 Krueger

## **2.2 RETURN AND EXHAUST GRILLES**

- .1 General: with opposed blade dampers as indicated, concealed manual operator and gaskets
- .2 Type R1: aluminum, channel border, 15 x 15 mm (1/2" x 1/2") egg crate type face bars, baked off white finish. Model: E.H. Price 80CH.
- .3 Type E1: aluminum 25 mm (1") border, 15 mm x 15 mm (1/2" x 1/2") egg crate type face bars, baked off white finish, screwed fastening. Model: E.H. Price 80-FA.
- .4 Type, size, and capacity: as indicated.

## **2.3 DIFFUSERS**

- .1 General: volume control dampers with flow straightening devices and blank-off quadrants, as indicated and gaskets.
- .2 Type D1: 3-cone adjustable, steel, square type, having adjustable pattern, adjustable baffle, baked off white finish, lay-in and or surface mounted. Model: EH Price SCDA.
- .3 Type, size, and capacity: as indicated.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install in accordance with manufacturer's instructions.
- .2 Install with flat head screws in countersunk holes where fastenings are visible.
- .3 Bolt grilles, registers and diffusers, in place
- .4 Provide concealed safety chain on each grille, register and diffuser in gymnasium, similar game rooms, and on exposed diffusers, and elsewhere as indicated.
- .5 Clean grilles upon completion.
- .6 Paint ductwork beyond grilles, matte black where visible.
- .7 Ensure all grilles, diffusers, etc. match opening sizes as indicated on the drawings and as fabricated on site by the contractor.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ASTM E90, Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions, and Elements.

**1.2            PRODUCT DATA**

- .1 Submit product data in accordance with general requirements.
- .2 Indicate the following:
  - .1 Pressure drop.
  - .2 Face area.
  - .3 Free area.
  - .4 Colour and finish.

**1.3            CERTIFICATION OF RATINGS**

- .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

**1.4            TEST REPORTS**

- .1 Submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.

**Part 2            Products**

**2.1            GRAVITY ROOF OUTSIDE AIR INTAKES AND RELIEF VENTS**

- .1 Factory manufactured louvred penthouse.
  - .1 3 mm (1/8") thick stormproof extruded aluminum louvers with mitred corners. Brace and support louvres at 1500 mm (5') intervals.
  - .2 2 mm (0.081") thick insulated aluminum sheet roof.
  - .3 Constructed of 50 mm x 50 mm x 6 mm (2" x 2" x ¼") aluminum angles for roof support and corner angle.
  - .4 15 mm x 15 mm x 0.063 diameter (½" x ½" x 1.6" diameter) intercrimp aluminum screen on back of all sides.
- .2 Provide roof curb sized to suit penthouse or flat or sloped roof as required or indicated. Curb to place bottom louvre minimum 250 mm (10") above roof.
- .3 Maximum throat velocity 3.3 m/s (11 ft/s) intake.
- .4 Maximum loss through unit: 15 Pa (0.06" in w.c.) static pressure.

- .5 Finish: Powder Coated. Color selected by Consultant.
- .6 Shape and size as indicated.
- .7 Acceptable manufacturers:
  - .1 Greenheck WRH
  - .2 Nailor 1720
  - .3 Carnes GLAB
  - .4 Penn Barry
  - .5 Ventex
  - .6 Pottorff

## **2.2 GOOSENECK HOODS**

- .1 Thickness: to ASHRAE and SMACNA.
- .2 Fabrication: to ASHRAE and SMACNA.
- .3 Joints: to ASHRAE and SMACNA and or proprietary manufactured duct joint.
  - .1 Acceptable material:
    - .1 Ductmate Canada
    - .2 Exanno Nexus
- .4 Supports: as indicated.
- .5 Complete with integral birdscreen of 2.7 mm (12 gauge) diameter aluminum wire. Use 15 mm (1/2") mesh on exhaust 20 mm (3/4") mesh on intake.
- .6 Vertical or Horizontal backdraft dampers as required.
- .7 Prefabricated roof curb through roof complete with insulation and counter flashing.

## **2.3 FIXED LOUVRES – ALUMINUM**

- .1 Construction: welded with exposed joints ground flush and smooth.
- .2 Material: extruded aluminum alloy 6063-T5.
- .3 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500 mm (60").
- .4 Frame, head, sill and jamb: 100 mm (4") deep one piece extruded aluminum, minimum 3 mm (1/8") thick with approved caulking slot, integral to unit.
- .5 Mullions: at 1500 mm (60") maximum centres.
- .6 Fastenings: stainless steel (Society of Automotive Engineers) SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.
- .7 Screen: 15 mm (1/2") exhaust 20 mm (3/4") intake mesh, 2 mm (5/64") diameter wire aluminum birdscreen on inside face of louvres in formed U-frame.

.8 Finish:  
Powder Coated  
Colour: to Consultant's approval.

.9 Acceptable materials:

- .1 Greenheck
- .2 Construction Specialties
- .3 E.H. Price
- .4 Krueger
- .5 Ruskin
- .6 Ventmaster
- .7 Ventex
- .8 Nailor

## **2.4 BRICK VENTS (FLANGE FRAME)**

.1 Construction: welded with exposed joints ground flush and smooth.

.2 Material: extruded aluminum alloy 6063-T5.

.3 Blade: stormproof pattern.

.4 Perimeter flange frame, head, sill and jamb: 40 mm (1½") deep one piece extruded aluminum, minimum 3 mm (1/8") thick with approved caulking slot, integral to unit.

.5 Fastenings: stainless steel (Society of Automotive Engineers) SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.

.6 Screen: 15 mm (1/2") exhaust 20 mm (3/4") exhaust mesh, 2 mm (5/64") diameter wire aluminum birdscreen on inside face of louvres in formed U-frame.

.7 Finish:  
Powder Coated  
Colour: to Consultant's approval.

.8 Options:

- .1 Straight duct extension.
- .2 Perimeter flange frame.

.9 Acceptable materials:

- .1 Greenheck Model BVF
- .2 Construction Specialties
- .3 E.H. Price
- .4 Krueger
- .5 Ruskin
- .6 Ventmaster
- .7 Ventex
- .8 Nailor

## **2.5 ALUMINUM WALL CAPS (CLOTHES DRYER)**

- .1 Application: Clothes dryer or as noted on drawings.
- .2 0.3 mm (16 gauge) aluminum wall sleeve sized as noted on plans.
- .3 0.3 mm (16 gauge) sloping exterior wall cap with integral sides, base plate, and 25 mm (1") perimeter flange with 4-hole screw fasten. Fasteners at each corner.
- .4 Bottom outlet with removable 15 mm x 15 mm (1/2") x (1/2") aluminum screen.
- .5 Neoprene backdraft damper with aluminum crimp on bottom edge.
- .6 Acceptable materials:
  - .1 Reversomatic
  - .2 Broan
  - .3 Ventex
  - .4 AirVent
  - .5 Shop fabricated (submit sample for approval).

## **2.6 WALL BOXES**

- .1 0.3 mm (16 gauge) aluminum wall sleeve sized as noted on plans.
- .2 Extruded aluminum grille, 25 mm (1") perimeter flange with 4-hole screw fasten.
- .3 Bottom outlet with removable 15 mm x 15 mm (1/2") x (1/2") aluminum screen.
- .4 Neoprene backdraft damper with aluminum crimp on bottom edge.
- .5 Acceptable materials:
  - .1 Reversomatic
  - .2 Broan
  - .3 Ventex
  - .4 AirVent
  - .5 Shop fabricated (submit sample for approval).

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 In accordance with manufacturers and SMACNA recommendations.
- .2 Reinforce and brace air vents, intakes and goosenecks as indicated.
- .3 Anchor securely into opening.
- .4 Seal with caulking all around to ensure weather tightness.

**END OF SECTION**

**Part 1 General**

**1.1 PRODUCT DATA**

- .1 Submit product data in accordance with general requirements.

**1.2 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with general requirements.
- .2 Clearly indicate following:
  - .1 Methods of sealing sections.
  - .2 Methods of expansion.
  - .3 Details of thimbles.
  - .4 Bases/Foundations.
  - .5 Supports.
  - .6 Guy details.
  - .7 Rain caps.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Submit operation and maintenance data for incorporation into manual specified in general requirements.

**1.4 CERTIFICATIONS**

- .1 Catalogued or published ratings shall be those obtained from tests carried out by independent testing agency or manufacturer signifying adherence to codes and standards.

**Part 2 Products**

**2.1 POSITIVE PRESSURE VENTING (CATEGORY III AND IV)**

- .1 **The vent shall be of the double wall, factory-built type, designed for use in conjunction with Category III, or IV condensing or non-condensing positive pressure appliances or as specified by the heating equipment manufacturer.**
- .2 Maximum continuous flue gas temperature shall not exceed 550 degrees F (288 degrees C).
- .3 Vent shall be listed for a maximum positive pressure rating of 6.0" w.c. and shall have passed testing at 15.0" w.c.
- .4 The vent system shall be continuous from the appliance's flue outlet to the vent termination outside the building. All systems components shall be ULC listed and supplied by the same manufacturer.
- .5 The vent shall be constructed with an inner and outer tube, with an annular space between the tubes of 25 mm (1").

- .6 The inner tube (flue gas conduit) shall be constructed from AL29 4C® or UNS S44735 stainless steel, with a min. wall thickness of 0.4 mil (26 ga) for 3" through 7" diameter vents, 0.5 mil (24 ga) for 8" through 12" diameter vents and 0.6 mil (22 ga) for 14" and 16" diameter vents.
- .7 The outer tube (jacket) shall be constructed from 304 or 430 stainless steel, with a minimum wall thickness of 0.4 mil (26 ga) for 3" through 6" diameter vents and 0.6 mil (22 ga) for 7" through 16" diameter vents.
- .8 All systems components such as vent supports, roof or wall penetrations, terminations, appliance connectors and drain fittings required to install the vent system shall be UL listed and provided by the vent manufacturer.
- .9 All system components shall include a factory-installed gasket in their female-end to render the vent air and water tight when the male/female ends are pushed together as per manufacturer's instructions. Vent systems requiring field installed sealants or compounds shall not be acceptable.
- .10 All systems components shall include a factory installed, internal mechanical locking band for fastening and securing all vent components against each other.
- .11 Vent layout shall be designed and installed in compliance with manufacturer's installation instructions boiler manufacturer, and all applicable local codes.
- .12 Acceptable Manufacturers:
  - .1 Pro Tech Systems, Inc. – FasNSeal W2 (Insulated)
  - .2 Van Packer
  - .3 Z-Flex Model SVE-IV (Insulated)
  - .4 Cheminée Lining
  - .5 Selkirk/Ampco
  - .6 Security Chimneys International
  - .7 ICC Chimney VIP

## **2.2 TYPE A GAS VENT**

- .1 ULC labelled, 537° C (1000° F) rating maximum, atmospheric gas vent only.
- .2 Sectional, prefabricated, double wall with 50 mm (2") insulated cavity. Stainless steel inner wall. Stainless steel outer wall. Mated fittings and couplings.

## **2.3 ACCESSORIES**

- .1 Cleanouts: bolted, gasketed type, full size of breeching, as indicated.
- .2 Barometric dampers: double acting, 70% of full size of breeching area.
- .3 Hangers and supports: in accordance with recommendations of Sheet Metal and Air Conditioning Contractors National Association Inc. (SMACNA)
- .4 Rain cap.
- .5 Expansion sleeves with heat resistant caulking, held in place as indicated.



- .6 Roof flashing cones.
- .7 Guy wire supports and anchors.

**Part 3 EXECUTION**

**3.1 INSTALLATION – GENERAL**

- .1 Follow manufacturer's and SMACNA installation recommendations for shop fabricated components.
- .2 Suspend breeching at 1.5 m (5') centres and at each joint.
- .3 Support chimneys at bottom, roof and intermediate levels as indicated.
- .4 Install thimbles where penetrating roof, floor, ceiling and where breeching enters masonry chimney. Pack annular space with heat resistant caulking.
- .5 Install flashings on chimneys penetrating roofs, and building structures.
- .6 Install rain caps and cleanouts, as indicated.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 Canadian Standards Association (CSA).
  - .1 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.
- .3 Canadian Gas Association (CGA).
  - .1 CAN1-3.1, Industrial and Commercial Gas-Fired Package Boilers.
  - .2 CSA-B149.1, Natural Gas and Propane Installation Code.
- .4 American National Standards Institute (ANSI).
  - .1 ANSI Z21.13, Gas-Fired Low-Pressure Steam and Hot Water Boilers.
- .5 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME).
  - .1 ANSI/ASME Boiler and Pressure Vessel Code, Section IV.
- .6 ASHRAE 90.1 – Energy Standard for Building Except Low-Rise Residential Buildings

**1.2            BOILER SYSTEM LAYOUT ON FLOOR**

- .1 Pre-planning of the boiler room system must be done prior to any new construction in the boiler room beginning. The contractor shall provide a full scale markup of the boiler system on the floor of the boiler room. The markup shall be in various coloured chalk and shall include all the components/equipment of the boiler system.
  - .1 Housekeeping pad sizes/locations.
  - .2 Floor/hub drain locations.
  - .3 Vent/chimney stack locations and locations thru roof.
  - .4 Boiler positions (including burner & front door swing – depending on type of boiler).
  - .5 Rough locations and routing for heating supply/return headers and branch piping.
  - .6 Location of gas train (compared to boiler access/door swing) so gas can be disconnected from one or two unions.
  - .7 Locations for pumps, air separator, sink, eyewash, expansion tanks, etc.
  - .8 Locations for chemical treatment pot feeder assembly and makeup water assembly.
  - .9 Coordinate with the electrician and include markup locations for starters, panels, VFDs, etc.
  - .10 Location of unistrut supports where needed to route wiring or mount piping or equipment.
  - .11 Location of BAS controls & panels.

- .2 Markup shall be reviewed with the consultant and owner prior to new installations starting. Changes or adjustments of the layout will be made with chalk during the review.
- .3 Contractor to provide multiple photos of the final chalk layout.

### **1.3 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with general requirements.
- .2 Indicate the following:
  - .1 Capacities of selected model
  - .2 General arrangement showing terminal points, instrumentation test connections.
  - .3 Clearances for operation, maintenance, servicing, cleaning.
  - .4 Piping hook-ups.
  - .5 Equipment electrical drawings.
  - .6 Burners and controls.
  - .7 All miscellaneous equipment.
  - .8 Flame safety control system.
  - .9 Breeching and stack configuration.
  - .10 Warranty information
- .3 Engineering data to include:
  - .1 Boiler efficiency at 100% of design capacity.
  - .2 Radiant heat loss at 100% design capacity.
  - .3 Water side pressure drop curve
  - .4 Certificate of Product Rating: AHRI Certificate indicating Thermal Efficiency, Combustion Efficiency, Materials of Construction, Input and Gross Output

### **1.4 CLOSEOUT SUBMITTALS**

- .1 Submit operation and maintenance data for incorporation into manual specified in general requirements.

### **1.5 CERTIFICATION**

- .1 Manufacturer's Certification: The boiler manufacturer shall certify the following:
  - .1 The products and systems furnished are in strict compliance with the specifications.
  - .2 the boiler, burner and other associated mechanical and electrical equipment have all been properly coordinated and integrated to provide a complete and operable boiler.
  - .3 ASME certification.
  - .4 CSA (AGA/CGA) certification.
  - .5 The specified factory tests have been satisfactorily performed.

- .6 The equipment furnished contains inter-changeable parts with the specified equipment so that all major equipment parts can be obtained from the specified manufacturer.

## **Part 2 Products**

### **2.1 GENERAL**

- .1 Furnish the number of factory "packaged" low pressure hot water boilers indicated on the drawings. Each factory "packaged" boiler shall be complete with all components, accessories, and appurtenances necessary for a complete and operable boiler as hereinafter specified. Each unit shall be furnished factory assembled with required wiring and piping as a self-contained unit. Each unit shall be readily transported and ready for installation.
- .2 Each hot water boiler shall consist of a vertical, stainless steel heat exchanger complete with trim, valve trains, burner, and boiler control system. The boiler manufacturer shall fully coordinate the boiler as to the interaction of its elements with the burner and the boiler control system in order to provide the required capacities, efficiencies, and performance as specified.
- .3 The boiler manufacturer shall provide unit responsibility for the engineering, coordination, workmanship, performance, warranties, and all field services for each factory "packaged" boiler as specified herein. The boiler manufacturer shall be fully responsible for all components assembled and furnished by him whether or not they are of his own manufacture.

### **2.2 PERFORMANCE CRITERIA**

- .1 Refer to schedules for boiler capacities.
- .2 Boiler shall be capable of operating with a minimum outlet water temperature of 20°C (68°F).
- .3 Boiler shall comply with ASME Section IV for 345 kPa (50 psig) (max 98°C/200°F).
- .4 Boiler relief valve setting shall be 345 kPa (50 psig) max.
- .5 Maximum allowable water temperature shall be 210°F
- .6 **Minimum Water Flow Rate: 10GPM**
- .7 Fuel shall be natural gas with an assumed higher heating value of 1,030 Btu/Cu Ft and an assumed specific gravity of 0.60 (relative to air). Natural gas shall be supplied at a pressure of no less than 3.5" w.c. to the inlet gas valve. Maximum inlet gas pressure shall not exceed 14" w.c.
- .8 Ambient air temperature shall be assumed to range from 10°C (50°F) to 32°C (90°F) with an average of 21°C (70°F).
- .9 Power voltage shall be 120/208 vac, 1-phase, 60 hertz. Control voltage shall be 24 vac (transformer to be supplied by boiler manufacturer).
- .10 Boiler shall be suitable for use with either water or glycol solutions.

### **2.3 HEAT EXCHANGER**

- .1 Each boiler heat exchanger shall be duplex stainless steel, single or multi-pass, down fire, counter-flow design for maximum heat transfer with the multiple sections arranged in a reverse return configuration to assure balanced flow through each section
- .2 Boiler heat exchanger headers shall be fabricated stainless steel and be completely removable for inspection. Seals shall be EPDM, rated for 400°F service. Push nipples or gaskets between the sections are not permitted.
- .3 Heat exchange capability shall be maximized through the use of a corrugation process or fins.

### **2.4 PRESSURE VESSEL**

- .1 Shall be constructed of carbon stainless steel with welded heads and tube connections.
- .2 Pressure vessel shall be counter-flow design for water flow, with internal water baffling plates if required to meet energy efficiency requirements.
- .3 The water volume of the boiler shall not be less than 42 gallons of water volume/1000 MBH.
- .4 The pressure vessel shall have sufficient water capacity to be flow tolerant without minimum flow requirements or the use of a flow switch.  
  
The allowable pressure drop across the boiler inlet and outlet connections shall not exceed 2.0 psi/4.6 ft H<sub>2</sub>O if the system is piped as a primary flow only. If the system is piped as primary-secondary flow the boiler manufacturer shall supply a boiler circulation pump suitable for the pressure drop across the boiler and all associated pipe isolation valves, strainers, etc.

### **2.5 FRAME AND ENCLOSURE**

- .1 Boiler shall be enclosed with a single wall outer casing. It shall be fabricated from a minimum 16 gauge carbon steel. The complete outer casing shall be finished, inside and out, with a powder coat finish.
- .2 The composite structure of the boiler combustion chamber, insulating air gap and outer casing shall be of such thickness and materials to assure an outer casing temperature of not more than 37°C (100°F) when the boiler is operated at full rated load.
- .3 An observation port shall be located on the boiler to allow for observation of the burner flame.
- .4 Access panels shall be hinged.
- .5 Provide appropriate NEMA 250, Type 1 enclosure for controls components.
- .6 Provide lifting eyes and fork holes accessible for rigging and movement of the boiler.
- .7 Minimum 2 inch thick insulation surrounding the heat exchanger.

### **2.6 CONNECTIONS**

- .1 Each boiler shall be provided with all necessary inlet and outlet connections. Boiler connections shall be as follows:
  - .1 One (1) water supply outlet, Victaulic

- .2 One (1) water return inlet, Victaulic
- .3 One (1) relief valve outlet.
- .4 One (1) flue gas vent outlet.
- .5 One (1) fuel gas inlet.
- .6 A flue gas outlet shall be located on the rear of the boiler. Boiler to be certified for installation with Category IV venting (stack) as defined in NFPA 54 (ANSI Z221), latest edition. Contractor must provide venting (stack) certified for installation on a Category IV appliance.

## **2.7 MAIN GAS VALVE TRAIN (MODULATING)**

- .1 Each boiler shall be provided with an integral main gas valve train. The main gas valve trains shall be factory assembled, piped, and wired. Each gas valve train shall include at least the following:
  - .1 One (1) manual shutoff valve (gas train inlet connection).
  - .2 Two (2) safety shutoff valves. Valves equipped with dual solenoids that can independently energized for leak testing.
  - .3 Modulating Air – Gas ratio control (maximum inlet pressure 14" w.c.).
  - .4 One (1) low gas pressure switch (manual reset).
  - .5 One (1) high gas pressure switch (manual reset).
  - .6 Two (2) pressure test ports.
  - .7 Union connection to permit burner servicing.

## **2.8 NEUTRALIZING VESSEL**

- .1 Rotationally molded low density polyethylene vessel with minimum 3" diameter fill/access openings at each end, 3/4" diameter inlet and outlet pipe connections. Provide all necessary mounting hardware. Unit (or units if more than 1 is required) is to be sized to neutralize capacity of condensate from boiler, before being drained to sewer system. Vessel to be sized to suit condensate produced by the boiler.
- .2 Provide initial charge of limestone and store one (1) additional charge where directed on site.
- .3 Acceptable materials: From boiler manufacturer.

## **2.9 IGNITION SYSTEM**

- .1 Each boiler shall be equipped for direct spark ignition.

## **2.10 COMBUSTION AIR CONTROL SYSTEM (DIGITAL)**

- .1 Each boiler shall be provided with an integral combustion air control system. The combustion air system shall be factory assembled. Each combustion air control system shall include at least the following:
  - .1 The primary control shall vary the speed of the blower based on load demand. The blower shall apply a varying negative pressure on the gas valve, which will open or close to maintain zero pressure at the valve orifice, thereby increasing or decreasing the firing rate. Both the air and gas shall be premixed in the blower.
  - .2 One (1) low airflow differential pressure switch to insure that combustion air is supplied.
  - .3 High exhaust back pressure switch.

## **2.11 VENTING**

- .1 The boiler shall be capable of operating with a stack effect not exceeding -0.04" W.C. and a combined air intake and exhaust venting pressure drop not exceeding +1.50" W.C.
- .2 It shall be acceptable to either direct vent the boiler using sealed combustion by drawing combustion air in from the outdoors, or by drawing air from the mechanical space itself.
  - .1 Sealed Combustion: Contractor shall supply and install venting to suit manufacturers installation guidelines.
  - .2 Mechanical Space: Manufacturer shall supply and install filter for combustion air intake if required or recommended by manufacturer.
- .3 Flue Gas exhaust stack shall be AL 29-4C, 316L stainless steel or other material as indicated in manufacturer installation manual. Material shall be listed and labelled to UL 1738 / COUL S636 for use with Category IV appliances. Material shall be guaranteed appropriate for the application by the manufacturer of the boiler.
- .4 Condensate drain material must be stainless steel or Schedule 40 CPVC. Copper, carbon steel, or PVC pipe materials are not acceptable.
- .5 **Obtain boiler manufacturer approval of venting (route, termination, and material).**

## **2.12 CONTROL PANEL**

- .1 The boiler manufacturer shall provide each boiler with an integral factory prewired control panel. The control panel shall contain at least the following components, all prewired to a numbered terminal strip:
  - .1 One (1) burner "on-off" switch.
  - .2 One (1) electronic combination temperature control, flame safeguard and system control.
  - .3 Control circuit breaker, 5 amp.
  - .4 All necessary control switches, pushbuttons, relays, timers, terminal strips, etc.

## **2.13 INTERNAL CONTROL**

- .1 Boiler control system shall consist of an integral boiler display and micro-processor control system.
- .2 LCD Display Panel to adjust set points and control operating parameters. LCD display to indicate burner sequence, all service codes (0-65), fan speed, boiler set point, sensor values such as inlet, outlet, flue gas and outdoor air.
- .3 Control system shall be capable of controlling/staging multiple boiler systems, as well as starting/stopping primary boiler pumps, varying primary pump speed based on boiler firing rate. Boiler shall be able to control minimum two separate heating loops.
- .4 In a multiple boiler system, the control shall stage and modulate the boilers utilizing firing rate threshold staging and parallel modulation to optimize condensing potential while minimizing energy wasting short cycling. The control shall monitor the supply water temperature and return water temperature and communicate between the boilers on a local boiler system control network.
- .5 Boiler controls shall have provisions for outside air reset and night setback. Boiler manufacturer to provide outdoor air temperature sensor.
- .6 All parameters shall be adjustable through the control panel display.
- .7 Boiler control panels shall be mounted and located on the boiler to provide ease of servicing and prevent accidental water damage.
- .8 The integral controller on each boiler shall provide for the following functions:
  - .1 Flame safeguard
  - .2 Burner sequencing, with safe start check, pre-purge, electronic direct spark ignition and post-purge. Combustion shall be proven.
  - .3 Flame Supervision: Maintain a running history of operating hours, number of cycles, and the most recent lockouts. Display information on display screen in clear English text descriptions without the need to look up error codes.
  - .4 Safety Shutdown with display of lockout and hold condition.
  - .5 PID modulating control of the variable speed fan for firing capacity relative to load requirements. i.e. to meet supply water temperature set point.
  - .6 Gas Pressure supervision (high and low)
  - .7 Combustion Air Proving supervision
  - .8 High Air Pressure (Back draft too high) supervision
  - .9 Control relay for operation of the isolation valve.
  - .10 Low Water Cut Off (provide for field installation if not integral to boiler)

## **2.14 BAS HARDWIRE INTEGRATION**

- .1 Terminal Strip Integration: Boiler shall communicate with the BAS via a terminal strip integration. Provide the following points for integration:
  - .1 Boiler Enable/Disable
  - .2 Boiler Status
  - .3 Boiler Alarm



- .4 Hot Water Supply and Return Water Temperature Set Point
- .5 Boiler modulation rate
- .6 Firing Rate feedback

## **2.15 BACNET INTEGRATION**

- .1 The boiler shall also include for the addition of the BACNet integration.
- .2 Through digital integration the following minimal information shall be controlled and visible:
  - .1 Writeable Points
    - .1 Hot Water Supply Temperature Set Point
    - .2 Hot Water Return Temperature Set Point
    - .3 Fire rate
    - .4 System/Boiler Pump Command
    - .5 Boiler Enable/Disable
    - .6 Lead/Lag Control (enable and settings)
    - .7 Emergency Shut down
  - .2 Readable Points
    - .1 Hot Water Supply Temperature
    - .2 Hot Water Return Temperature
    - .3 Fire Rate Feedback
    - .4 Failure/Alarm
    - .5 Cycle/Run Time totals
    - .6 Flow verification (if equipped with internal flow switch)
    - .7 Pump status
    - .8 Combustion efficiency
    - .9 Various operating status' as available in standard BACNet integration offering
  - .3 Lock out and error codes shall be transmitted to the BAS and be readable at the Operator Workstation so that error codes can be remotely accessed and reviewed prior to site visit. Manufacturer shall provide correct controller to provide this functionality.

## **2.16 ELECTRICAL CONNECTION**

- .1 Provide single point field power connection, factory installed and wired, including all transformers, control/safety devices and other devices as required for a complete and operable system.
- .2 Power shall be 120 V, 60 Hz, single phase. Maximum 20 Amp breaker.

**2.17 TRIM**

- .1 Boiler shall be provided with all necessary trim. Boiler trim shall be as follows:
  - .1 Safety relief valve shall be provided in compliance with the ASME code. Contractor to pipe to acceptable drain.
  - .2 Water pressure temperature gauge.
  - .3 Primary low water flow fuel cutoff (probe type with manual reset).
  - .4 High limit water temperature controller to stop burner operation at excess water temperature (shall be manual reset).
  - .5 Operating temperature control to control the sequential operation of the burner.
  - .6 Separate inlet and outlet water temperature sensors capable of monitoring flow.
  - .7 Alarm lights and horn
  - .8 LCD Display and Diagnostics
  - .9 Strainer in piping system ahead of each boiler.

**2.18 ACCESSORIES**

- .1 Condensate neutralizing system
- .2 Drain Valve
- .3 **Flow Switch (if required for boiler operation or indicated on plans)**
- .4 **Boiler Circulating pump**
- .5 **BACNet integration card and any required protocol translators for boiler integration with the Building Management System.**
- .6 **Outdoor Air Temperature Sensor.**
- .7 **Auto restart (on loss of power).**
- .8 **Internal On/Off/Auto switch.**
  - .1 **Auto for BAS control.**
  - .2 **On for manual operation of boiler, with internal safeties and temperature setpoint.**

**2.19 ACCEPTABLE MATERIALS**

- .1 Patterson-Kelly
- .2 Lochinvar
- .3 Viessman

---

**Part 3                      Execution**

**3.1                      INSTALLATION**

- .1 Contractor shall install boilers in accordance with all manufacturer installation instructions and as indicated on the drawings.
- .2 Meet all local and applicable codes of installation.
- .3 Maintain manufacturer's recommended service clearances on all sides of the equipment.
- .4 Supplying contractor shall install all shipped loose equipment.
- .5 Supplying contractor shall be responsible for all interconnecting electrical control and power wiring, including high voltage wiring between boiler and isolation valve actuator.
- .6 Install boilers on cast-in-place concrete housekeeping pads.
- .7 Provide strainers on the inlet water piping.

**3.2                      QUALITY CONTROL**

- .1 Boiler shall be provided by a firm regularly engaged in the manufacture of condensing hydronic boilers with welded steel pressure vessels, whose products have been in satisfactory use in service for not less than ten (10) years.
- .2 Each factory "packaged" boiler shall be hydrostatically tested and bear the ASME "H" stamp.
- .3 Each factory "packaged" boiler shall be fire tested. The boiler manufacturer shall perform this fire test under simulated operating conditions, with the boiler attached to a working chimney system and with water circulating through the boiler. The manufacturer shall provide a fire test report, including fuel and air settings and combustion test results permanently affixed to the boiler.
- .4 The manufacturer shall have a factory authorized service training program, where boiler technicians can attend a training class and obtain certification to perform start-up, maintenance and basic troubleshooting specific to the product line. There shall be a minimum of 4 trained technicians within 100 km of the job site.
- .5 Provided equipment shall be of the type, design and size that the manufacturer currently offers for sale and must appear in the manufacturer's current catalogue.

**3.3                      FIELD TESTING**

- .1 The boiler manufacturer shall field test the following:
  - .1 Boiler and burner interlocks.
  - .2 Valves.
  - .3 Controllers.
  - .4 Gauges.
  - .5 Thermometers.
  - .6 Alarms
  - .7 Stack Pressure

- .8 Switches.
- .9 LCD Screen Functional Test
- .10 Any malfunctioning component shall be replaced.

### **3.4 COMMISSIONING**

- .1 Manufacturer to:
  - .1 Certify installation.
  - .2 Start up and commission installation.
  - .3 Carry out on-site performance verification tests.
  - .4 Demonstrate operation and maintenance.
- .2 Provide Consultant at least 48h notice prior to inspections, tests, and demonstrations. Submit written report of inspections and test results.

### **3.5 DEMONSTRATION AND TRAINING**

- .1 Provide minimum 2 hours training to owner's representative, including all safety procedures, maintenance procedures, control operations and diagnostic procedures.
- .2 Training shall be provided by a factory trained service technician.
- .3 Training shall occur at the installed location.

### **3.6 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
  - .2 Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within the specified period:
    - .1 Pressure Vessel and Heat Exchanger: The boiler manufacturer shall warranty against failure due to thermal shock, flue gas condensate corrosion, and/or defective material or workmanship for a period of 10 years, non-prorated, from the date of Ready for Takeover provided the boiler is installed, controlled, operated, and maintained in accordance with the Installation, Operation and Maintenance Manual.
    - .2 Burner: The boiler manufacturer shall warranty the burner against defective material or workmanship for a period of five (5) years, non-prorated, from the date of Ready for Takeover.

- .3 All other Components: The boiler manufacturer will repair or replace any part of the boiler that is found to be defective in workmanship or material within twelve (12) months from the date of Ready for Takeover.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ANSI/ARI 210/240, Unitary Air-Conditioning, and Air-Source Heat Pump Equipment.
- .3 ARI 270, Standard for Sound Rating of Outdoor Unitary Equipment.
- .4 CSA C22.1, Canadian Electrical Code, Part 1.
- .5 ANSI/NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
- .6 ANSI/UL 1995, Central Cooling Air Conditioning.
- .7 AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
- .8 AMCA 99 – Standards Handbook
- .9 AMCA 500 – Test Methods for Louver, Dampers, and Shutters.
- .10 AHRI 340/360 – Unitary Large Equipment.
- .11 NEMA MG1 – Motors and Generators.
- .12 National Electrical Code.
- .13 NFPA 70 – National Fire Protection Agency.
- .14 SMACNA – HVAC Duct Construction Standards – Metal and Flexible.
- .15 UL 900 – Test Performance of Air Filter Units.
- .16 C.1 CSA B52-2023, Mechanical Refrigeration Code
- .17 C.2 CAN/CSA-C22.2 No 60335 Safety of Household and similar electrical appliances – Heat Pumps, Air-conditioners and dehumidifiers

**1.2            SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with general requirements.
- .2 Indicate:
  - .1 Equipment, and connections, together with control assemblies, auxiliaries and hardware, and recommended ancillaries which are mounted, wired and piped ready for final connection to building system, its size and recommended bypass connections.
  - .2 Piping, valves, fitting shipped loose showing final location in assembly.
  - .3 Control equipment shipped loose, showing final location in assembly.
  - .4 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, mounting curb details, sizes and location of mounting bolt holes; include mass distribution drawings showing point loads.

- .5 Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories, controllers.
- .6 Details of vibration isolation.
- .7 Estimate of sound levels to be expected across each individual octave band in dB referred to A rating.
- .8 Type of refrigerant used (A1 or A2L type only).

### **1.3 MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.
- .2 Indicate:
  - .1 Brief description of unit, indexed, with details of function, operation, control, and service for each component.
- .3 Manufacturer's installation instructions shall govern and unless otherwise noted, operation, maintenance, and service of items. Include names and addresses of spare part suppliers.
- .4 Include following:
  - .1 Provide for each unit, manufacturer's name, type, year, number of units, and capacity.

## **Part 2 Products**

### **2.1 MANUFACTURERS**

- .1 Daikin Applied DPS (Vision)
- .2 Aeon
- .3 Engineered Air

### **2.2 GENERAL DESCRIPTION**

- .1 Furnish as shown on plans, Single zone Heating and Cooling Unit(s). Unit performance and electrical characteristics shall be per the job schedule
- .2 Configuration: Fabricate as detailed on prints and drawings:
  - .1 Return plenum/economizer section complete with power exhaust
  - .2 Filter section
  - .3 Cooling coil section
  - .4 Supply fan section
  - .5 Condensing unit section
- .3 The complete unit shall be cETLus listed.
- .4 The unit shall be ASHRAE 90.1-2016 compliant and labeled.

- .5 Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Each unit shall be completely factory assembled and shipped in one piece. Packaged units shall be shipped fully charged with refrigerant and oil.
- .6 The unit shall undergo a complete factory run test prior to shipment. The factory test shall include a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.
- .7 All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up report forms shall be supplied with each unit.
- .8 Efficiency:
  - .1 Units under 5 tons of cooling meet a SEER rating of 14.0.
  - .2 Units 6 tons of cooling and larger meeting an EER rating of 12.0 (9.6 for 12 ½ ton unit).
  - .3 Electronic controls with data link and diagnostic operation.
  - .4 Energy Star rated.

## **2.3 CABINET, CASING, AND FRAME**

- .1 Panel construction shall be double-wall construction for all panels. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance. Insulation shall be a minimum of 2" thick with an R-value of 13.0 and shall be 2-part injected foam. Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 5.0 inches w.g.
- .2 Exterior surfaces shall be constructed of painted galvanized steel, for aesthetics and long-term durability. Paint finish will include a base primer with a high-quality polyester resin topcoat
- .3 Service doors shall be provided on the fan section, filter section, control panel section, and heating vestibule in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless-steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.
- .4 The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base to accept cable or chain hooks for rigging the equipment.



## **2.4 OUTDOOR/RETURN AIR SECTION**

- .1 Unit shall be provided with an outdoor air economizer section. The economizer section shall be fully integral to the mechanical cooling and allow up to 100% of mechanical cooling if needed to maintain the cooling discharge air temperature. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include moisture eliminator filters to drain water away from the entering air stream. The outside and return air dampers shall be sized to handle 100% of the supply air volume. The dampers shall be parallel blade design. Damper blades shall be gasketed with side seals to provide an air leakage rate of 1.5 cfm / square foot of damper area at 1" differential pressure in accordance with testing defined in AMCA 500. A barometric exhaust damper shall be provided to exhaust air out of the back of the unit. A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges.
- .2 Control of the dampers shall be by a factory installed direct coupled actuator. Damper actuator shall be of the modulating, spring return type. A comparative enthalpy control shall be provided to sense and compare enthalpy in both the outdoor and return air streams to determine if outdoor air is suitable for "free" cooling. If outdoor air is suitable for "free" cooling, the outdoor air dampers shall modulate in response to the unit's temperature control system.
- .3 Unit shall be provided with a 100% outdoor air hood. The 100% outdoor air hood shall allow outdoor air to enter from the back of the unit, at the draw-through filter section. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include a bird screen to prevent infiltration of foreign materials and a rain lip to drain water away from the entering air stream.

## **2.5 ENERGY RECOVERY (OPTION)**

- .1 The rooftop unit shall be provided with an AHRI certified rotary wheel air-to-air heat exchanger in a cassette frame complete with seals, drive motor and drive belt. The energy recovery wheel shall be an integral part of the rooftop unit with unitary construction and does not require field assembly. Bolt-on energy recovery units that require field assembly and section to section gasketing and sealing are not acceptable.
- .2 The wheel capacity, air pressure drop, and effectiveness shall be AHRI certified per AHRI Standard 1060. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment.
- .3 The rooftop unit shall be designed with a track so the entire energy recovery wheel cassette can slide out from the rooftop unit to facilitate cleaning.
- .4 The unit shall have 2" Merv 7 filters for the outdoor air before the wheel to help keep the wheel clean and reduce maintenance. Filter access shall be by a hinged access door with ¼ turn latches.

- .5 The matrix design shall have channels to reduce cross contamination between the outdoor air and the exhaust air. The layers shall be effectively captured in aluminum and stainless-steel segment frames that provide a rigid and self-supporting matrix. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belt(s) of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.
- .6 The total energy recovery wheel shall be coated with silica gel desiccant permanently bonded without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
- .7 Wheels shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning.
- .8 Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel. Wheels shall be connected to the shaft by means of taper lock hubs.
- .9 The exhaust air fan shall be a direct drive SWSI plenum fan. The exhaust fan shall be sized for the airflow requirements per the construction schedule. The unit controller shall control the exhaust fan to maintain building pressure. A VFD shall be provided for the exhaust fan motor, or the exhaust fan motor shall be an ECM motor. The rooftop unit shall have single point electrical power connection and shall be ETL listed.
- .10 The control of the energy recovery wheel shall be an integral part of the rooftop unit's DDC controller. The DDC controller shall have visibility of the outdoor air temperature, leaving wheel temperature, return air temperature, and exhaust air temperature. These temperatures shall be displayed at the rooftop units DDC controller LCD display. All of these temperatures shall be made available through the BACnet interface.
- .11 The rooftop unit DDC controller shall provide frost control for the energy recovery wheel. When a frost condition is encountered the unit controller shall (stop, slow down) the wheel. When in the frost control mode, the wheel shall be jogged periodically and not be allowed to stay in the stationary position.

## **2.6 EXHAUST FAN (OPTION)**

- .1 Exhaust fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The exhaust fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.

- .2 The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
- .3 The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of the supply air fan designed airflow to maintain the adjustable building pressure setpoint. The field shall mount the required sensing tubing from the building to the factory mounted building static pressure sensor.

## **2.7 FILTERS**

- .1 Unit shall be provided with a draw-through filter section. The filter rack shall be designed to accept a 2" prefilter and a 4" post filter. The unit design shall have a hinged access door for the filter section. The manufacturer shall ship the rooftop unit with 2" MERV 8 construction filters. The contractor shall furnish and install, at building occupancy, the final set of filters per the contract documents.
- .2 Provide two (2) sets of final filters.
- .3 Pre-filter to be MERV10 and post filter to be MERV13.

## **2.8 COOLING COIL**

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

## **2.9 HOT GAS REHEAT DEHUMIDIFICATION CONTROL**

- .1 Unit shall be equipped with a fully modulating hot gas reheat coil with hot gas coming from the unit condenser.

- .2 Hot gas reheat coil shall be a microchannel design. The aluminum tube shall be a microchannel design with high efficiency aluminum fins. Fins shall be brazed to the tubing for a direct bond. The capacity of the reheat coil shall allow for a 20°F temperature rise at all operating conditions.
- .3 The modulating hot gas reheat systems shall allow for independent control of the cooling coil leaving air temperature and the reheat coil leaving air temperature. The cooling coil and reheat coil leaving air temperature setpoints shall be adjustable through the unit controller. During the dehumidification cycle the unit shall be capable of 100% of the cooling capacity. The hot gas reheat coil shall provide discharge temperature control within +/- 2°F.
- .4 Each coil shall be factory leak tested with high-pressure air under water.

## **2.10 SUPPLY FAN**

- .1 Supply fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with fan blades that are continuously welded to the hub plate and end rim. The supply fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.
- .2 All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment.
- .3 Supply fan and motor assembly combinations larger than 8 hp or 22" diameter shall be internally isolated on 1" deflection, spring isolators and include removable shipping tie downs.
- .4 **Units over 15 tons:** the motor shall be T frame and open drip proof. Overload protection and speed control is provided by the factory installed VFD and rooftop unit controller. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
- .5 **Units 15 tons and under:** the fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
- .6 The supply fan shall be capable of airflow modulation from 30% to 100% of the scheduled designed airflow. The fan shall not operate in a state of surge at any point within the modulation range.

## **2.11 VARIABLE AIR VOLUME CONTROL**

- .1 **Units over 15 tons:** an electronic variable frequency drive shall be provided for the supply air fan. Each drive shall be factory installed out of the air stream in a conditioned cabinet. Drives shall meet UL Standard 95-5V. The completed unit assembly shall be listed by a recognized safety agency, such as ETL. Drives are to be accessible through a hinged door assembly. Mounting arrangements that expose drives to high temperature unfiltered ambient air are not acceptable.
- .2 The unit manufacturer shall install all power and control wiring.

- .3     **Units 15 tons and under:** the unit controller shall proportionally control the ECM motors on the supply fan based on space temperature. The unit controller shall increase/decrease the speed of the supply fan in order to maintain the space temperature within its setpoint and deadband. The unit controller shall provide discharge air temperature control with the compressor modulation.

## **2.12           HEATING SECTION**

### **.1           Gas Heat**

- .1       The rooftop unit shall include a natural gas heating section. The gas furnace design shall be one natural gas fired heating module factory installed downstream of the supply air fan in the heat section. The heating module shall be a tubular design with in-shot gas burners.
- .2       Each module shall have minimum four (4) stages of heating control for units under 15 tons and be modulating for larger units.
- .3       The heat exchanger tubes shall be constructed of stainless steel.
- .4       The module shall have an induced draft fan that will maintain a negative pressure in the heat exchanger tubes for the removal of the flue gases.
- .5       Each burner module shall have two flame roll-out safety protection switches and a high temperature limit switch that will shut the gas valve off upon detection of improper burner manifold operation. The induced draft fan shall have an airflow safety switch that will prevent the heating module from turning on in the event of no airflow in the flue chamber.
- .6       The factory installed DDC unit control system shall control the gas heat module. Field installed heating modules shall require a field ETL certification. The manufacturer's rooftop unit ETL certification shall cover the complete unit including the gas heating modules.

## **2.13           HEAT PUMP HEATING**

- .1       The evaporator coil, condenser coil, compressors and refrigerant circuit shall be designed for heat pump operation. The refrigerant circuit shall contain a 4-way reversing valve for the heat pump operation. The outdoor coil shall have an electronic expansion valve to control the refrigerant flow. The unit controller shall modulate the expansion valve to maintain compressor operation within the compressor operational envelope.
- .2       The refrigerant system shall have a pump-down cycle.
- .3       The unit shall have a natural gas furnace for hybrid heating. When the heat pump operation cannot maintain the discharge air temperature setpoint the natural gas furnace shall temper the airstream to the discharge air temperature setpoint.

## **2.14           CONDENSING SECTION**

- .1       Outdoor coils shall be cast aluminum, micro-channel coils. Plate fins shall be protected and brazed between adjoining flat tubes such that they shall not extend outside the tubes. A sub-cooling coil shall be an integral part of the main outdoor air coil. Each outdoor air coil shall be factory leak tested with high-pressure air under water.

- .2 Fan motors shall be an ECM type motor for proportional control. The unit controller shall proportionally control the speed of the condenser fan motors to maintain the head pressure of the refrigerant circuit from ambient condition of (0,25)-120°F. Mechanical cooling shall be provided to (0, 25) ° F. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.
- .3 The condenser fan shall be low noise blade design. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be of a composite material
- .4 The unit shall have scroll compressors. One of the compressors shall be an inverter compressor providing proportional control. The unit controller shall control the speed of the compressor to maintain the discharge air temperature. The inverter compressor shall have a separate oil pump and low oil safety protection.
- .5 Pressure transducers shall be provided for the suction pressure and head pressure. Temperature sensor shall be provided for the suction temperature and the refrigerant discharge temperature of the compressors. All of the above devices shall be an input to the unit controller and the values be displayed at the unit controller.
- .6 Each circuit shall be dehydrated, and factory charged with refrigerant and oil.
- .7 Refrigerant to be A1 or A2L classification.

## **2.15 REFRIGERATION DETECTION SYSTEM:**

- .1 The Refrigerant detection system shall meet the requirements of CSA B52 and have the following functionality:
  - .1 Utilize a set point, nonadjustable in the field, to generate a digital output signal to initiate mitigation actions to both internal safeties and external components in the ductwork (dampers, electric coils etc.). Signal shall be generated in not more than 30 seconds from sensor exposure to refrigerant concentration of 25% LFL (+0\$, -1%)
  - .2 Sensor within the equipment, near potential source of leaks.
  - .3 Field calibration of the system is not allowed.
  - .4 Be capable of detecting the refrigerant used in the system.
  - .5 Have self diagnostics
  - .6 Energize fans upon failure of a self-diagnostic check
  - .7 Activate refrigerant safety shut off valves in the event of a leak being detected.

---

## **2.16 ELECTRICAL**

- .1 Unit wiring shall comply with NEC requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with the unit shall be number and color-coded and labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 120-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply fan motors shall have contactors and external overload protection. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.
- .2 **Kilo Ampere Interrupting Capacity (kAIC) Rating**
  - .1 **Equipment shall be rated a interrupting capacity rating of 25 kAIC.**
  - .2 **All products supplied to the site shall meet or exceed this kAIC rating.**
  - .3 **The kAIC rating may be lowered to match or exceed the available fault current indicated on the Short Circuit Co-ordination Study completed by the electrical trade.**

## **2.17 CONTROLS**

- .1 Provide a complete integrated microprocessor based Direct Digital Control (DDC) system to control all unit functions including temperature control, scheduling, monitoring, unit safety protection, including compressor minimum run and minimum off times, and diagnostics. This system shall consist of all required temperature sensors, pressure sensors, controller and keypad/display operator interface. All MCBs and sensors shall be factory mounted, wired and tested.
- .2 The stand-alone DDC controllers shall not be dependent on communications with any on-site or remote PC or master control panel for proper unit operation. The microprocessor shall maintain existing set points and operate stand alone if the unit loses either direct connect or network communications. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. All factory and user set schedules and control points shall be maintained in non-volatile memory. No settings shall be lost, even during extended power shutdowns.
- .3 The DDC control system shall permit starting and stopping of the unit locally or remotely. The control system shall be capable of providing a remote alarm indication. The unit control system shall provide for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/disable, heat indication, cool indication, and fan operation.
- .4 All digital inputs and outputs shall be protected against damage from transients or incorrect voltages. All field wiring shall be terminated at a separate, clearly marked terminal strip.

- 
- .5 The DDC controller shall have a built-in time schedule. The schedule shall be programmable from the unit keypad interface. The schedule shall be maintained in non-volatile memory to ensure that it is not lost during a power failure. There shall be one start/stopper per day and a separate holiday schedule. The controller shall accept up to sixteen holidays each with up to a 5-day duration. Each unit shall also have the ability to accept a time schedule via BAS network communications.
- .6 The keypad interface shall allow convenient navigation and access to all control functions. The unit keypad/display character format shall be 4 lines x 20 characters. All control settings shall be password protected against unauthorized changes. For ease of service, the display format shall be English language readout. Coded formats with look-up tables will not be accepted. The user interaction with the display shall provide the following information as a minimum:
- .1 Return air temperature.
  - .2 Discharge air temperature.
  - .3 Outdoor air temperature.
  - .4 Space air temperature.
  - .5 Outdoor enthalpy, high/low.
  - .6 Compressor suction temperature and pressure.
  - .7 Compressor head pressure and temperature.
  - .8 Expansion valve position.
  - .9 Condenser fan speed.
  - .10 Inverter compressor speed.
  - .11 Dirty filter indication.
  - .12 Airflow verification.
  - .13 Cooling status.
  - .14 Control temperature (changeover).
  - .15 VAV box output status.
  - .16 Cooling status/capacity.
  - .17 Unit status.
  - .18 All time schedules.
  - .19 Active alarms with time and date.
  - .20 Previous alarms with time and date.
  - .21 Optimal start.
  - .22 Supply fan and exhaust fan speed.
  - .23 System operating hours.
    - .1 Fan
    - .2 Exhaust fan
    - .3 Cooling
    - .4 Individual compressor
    - .5 Heating



- .6 Economizer
  - .7 Tenant override
- .7 The user interaction with the keypad shall provide the following:
  - .1 Controls mode
    - .1 Off manual
    - .2 Auto
    - .3 Heat/Cool
    - .4 Cool only
    - .5 Heat only
    - .6 Fan only
  - .2 Occupancy mode
    - .1 Auto
    - .2 Occupied
    - .3 Unoccupied
    - .4 Tenant override
  - .3 Unit operation changeover control
    - .1 Return air temperature
    - .2 Space temperature
    - .3 Network signal
  - .4 Cooling and heating change-over temperature with deadband
  - .5 Cooling discharge air temperature (DAT)
  - .6 Supply reset options
    - .1 Return air temperature
    - .2 Outdoor air temperature
    - .3 Space temperature
    - .4 Airflow (VAV)
    - .5 Network signal
    - .6 External (0-10 vdc)
    - .7 External (0-20 mA)
  - .7 Temperature alarm limits
    - .1 High supply air temperature
    - .2 Low supply air temperature
    - .3 High return air temperature
  - .8 Lockout control for compressors.
  - .9 Compressor interstage timers
  - .10 Night setback and setup space temperature.
  - .11 Building static pressure.

- .12 Economizer changeover
  - .1 Enthalpy
  - .2 Drybulb temperature
- .13 Currently time and date
- .14 Tenant override time
- .15 Occupied/unoccupied time schedule
- .16 One event schedule
- .17 Holiday dates and duration
- .18 Adjustable set points
- .19 Service mode
  - .1 Timers normal (all time delays normal)
  - .2 Timers fast (all time delays 20 sec)
- .8 If the unit is to be programmed with a night setback or setup function, an optional space sensor shall be provided. Space sensors shall be available to support field selectable features. Sensor options shall include:
  - .1 Zone sensor with tenant override switch
  - .2 Zone sensor with tenant override switch plus heating and cooling set point adjustment. (Space Comfort Control systems only)
- .9 To increase the efficiency of the cooling system the DDC controller shall include a discharge air temperature reset program for part load operating conditions. The discharge air temperature shall be controlled between a minimum and a maximum discharge air temperature (DAT) based on one of the following inputs:
  - .1 Airflow
  - .2 Outside air temperature
  - .3 Space temperature
  - .4 Return air temperature
  - .5 External signal of 1-5 vdc
  - .6 External signal of 0-20 mA
  - .7 Network signal

## **2.18 SYSTEM CONTROL**

- .1 Equipment control will be by the unit manufacturer and integral economizer controls.
- .2 System controls will be by Building Automation System Contractor.

## **2.19 CAPACITY**

- .1 As indicated.

## **2.20 ACCESSORIES**

- .1 600 mm (24") high roof curb.

- .2 Leveling curb on sloped roof.
- .3 Vibration rail.
- .4 Opposed blade economizer dampers.
- .5 Condenser coil hail guard.
- .6 Power exhaust on units nominal 10 tons and larger (with field installed wiring).
- .7 Stainless steel vertical extension on flue gas discharge.
- .8 Stainless steel heat exchanger.

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 Install as per manufacturers' instructions on roof curbs provided by manufacturer as indicated. Provide all necessary continuous wolmanized wood blocking to install roof curb level complete with 20 gauge liner to ensure combustible wood blocking is not exposed in the building.
- .2 Manufacturer to certify installation, supervise start-up and commission unit.
- .3 Run drain line from cooling coil condensate drain pan to discharge over roof drain.

#### **3.2 START-UP/COMMISSIONING**

- .1 Unit manufacturer shall perform start-up and commissioning.

#### **3.3 ELECTRICAL REQUIREMENTS**

- .1 Field installed devices.
  - .1 Provide all field installed wiring required for all units that are equipped with power exhaust. Provide transformers as required.
- .2 Mount all accessories shipped loose onto the units.

#### **3.4 REFRIGERANT LEAK DETECTION SYSTEM**

- .1 This contractor shall provide all wiring between leak detection systems installed within the provided equipment and system components in the spaces served and ductwork system.
- .2 Specifically, the following shall occur for each independent system on registration of a refrigerant leak:
  - .1 Open all zone dampers in the affected system.
  - .2 Disable all electric reheat coils within the affected system.
  - .3 Activate field installed safety shut off valves within the affected refrigeration system.
  - .4 Energize all fans within the affected ductwork system.
  - .5 Activate and refrigerant leak system specific ventilation systems.

- .6 De-energize any other potential sources of ignition within the affected system.
- .3 All interlocks between field installed detection systems and associated safety system components shall be tested and verified to operate as per the requirements of CSA B52.

### **3.5 TRAINING**

- .1 Provide 2 hours training to owner's staff on the care, maintenance and operation of the equipment. Dedicated visit to site is required as it will not be paired with equipment startup.

### **3.6 SPARE PARTS**

- .1 Two (2) complete sets of filters.
- .2 One (1) set of spare belts.

### **3.7 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year on parts and labour on all components.
  - .2 Five (5) years on compressor.
  - .3 Ten (10) years on stainless steel heat exchanger.
  - .4 Manufacturer hereby warrants refrigeration compressors in accordance with GC 24, but for five (5) years.
  - .5 Manufacturer hereby warrants the gas heat sections for a minimum of ten (10) years.

**END OF SECTION**

**Part 1 General**

**1.1 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with general requirements.
- .2 Indicate:
  - .1 Equipment, capacity, piping, and connections.
  - .2 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, sizes and location of mounting bolt holes.
  - .3 Special enclosures.
- .3 Primer coat to be off white.
- .4 All hydronic heating shall be by a single manufacturer.

**1.2 MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.

**Part 2 Products**

**2.1 DAMPERS**

- .1 Factory built, internal damper, complete with operator, at enclosure air outlet grille for each convection type heating unit not thermostatically controlled. Refer to schedules on drawings.

**2.2 CAPACITY**

- .1 As indicated.

**2.3 FINNED TUBE RADIATION (H-5)(ELEMENT WITHOUT ENCLOSURE)**

- .1 Heating elements: NPS 32 mm (1 1/4") seamless copper tubing, 1.2 mm (18 gauge) minimum wall thickness, mechanically expanded into flanged collars of evenly spaced aluminum fins, 100 mm x 100 mm (4" x 4") nominal, 164 fins per meter (50 fins/ft.) suitable for sweat fittings.
- .2 Element hangers: cradle type providing unrestricted longitudinal movement on enclosure brackets. Space brackets 900 mm (36") centres maximum.
- .3 Provide for noiseless expansion of all components.
- .4 Expansion compensators: Flexonics at each section.
- .5 Coordinate installation of heating elements with millwork.

- .6 Acceptable materials:
  - .1 Engineered Air
  - .2 Slant Fin
  - .3 Sigma
  - .4 Rittling

## **2.4 FINNED TUBE RADIATION (H-3)**

- .1 Heating elements: NPS 32 mm (1 1/4") seamless copper tubing, 1.2 mm (18 gauge) minimum wall thickness, mechanically expanded into flanged collars of evenly spaced aluminum fins, 100 mm x 100 mm (4" x 4") nominal, 164 fins per meter (50 fins/ft) suitable for sweat fittings.
- .2 Element hangers: cradle type providing unrestricted longitudinal movement on enclosure brackets. Space brackets 900 mm (36") centres maximum.
- .3 Standard enclosures: 450 mm (18") high, 1.6 mm (16 gauge) thick steel complete with stamped grille, components for wall-to-wall or complete with die formed end caps having no knock-outs, with inside corners, outside corners, as indicated. Provide full length channel and sealer strip at top of wall edge. Height as indicated. Joints and filler pieces to be flush with cabinet. Support rigidly top and bottom, on wall mounted brackets. Joints and filler pieces to be clear of grilles located to provide easy access to valves and vents. Provide access doors for valves. Finish cabinet with factory applied baked primer coat. Enclosure height as indicated. Sloping (flat) top open (sloping) bottom.
- .4 Special enclosures: as indicated.
- .5 Dimensions for enclosures: measure site conditions. Do not scale from drawing.
- .6 Provide for noiseless expansion of all components.
- .7 Expansion compensators: Flexonics at each section by mechanical contractor as specified elsewhere.
- .8 Acceptable materials:
  - .1 Engineered Air WF-1A Series
  - .2 Slant Fin
  - .3 Sigma

## **2.5 CABINET UNIT HEATERS (H-1)**

- .1 Cabinet: surface or semi-recessed installation as indicated, 1.6 mm (16 gauge) thick steel with rounded exposed corners and edges, removable panels, glass fiber insulation and integral air outlet and inlet, Arrangement 4
- .2 Finish with factory applied primer coat.
- .3 Coils: aluminum fins mechanically bonded to copper tubes. Hydrostatically tested to 1 MPa (145 psi).
- .4 Fans: centrifugal double width wheels, statically and dynamically balanced, direct driven, sleeve bearings, resilient mounted.

- .5 Motor: multi-speed, tapped wound permanent split capacitor type with sleeve bearings, built-in thermal overload protection and resilient rubber isolation mounting.
- .6 Filters: removable permanent washable type.
- .7 Capacity and orientation as indicated.
- .8 Control:
  - .1 3 speed switch with integral overloads in cabinet.
  - .2 Low limit aquastat strapped on to hot water heating supply set to prevent fan operating below 27°C (81°F).
  - .3 Control thermostat: electric, rated to suit cabinet heater, with setpoint locking device and concealed adjustment.
    - .1 Remote thermostat and locking guard cover on downflow units.
    - .2 Integral thermostat with access door on upflow units.
    - .3 Remote thermostat and guard by BAS contractor.
- .9 Acceptable materials:
  - .1 Engineered Air CUH Series
  - .2 Slant Fin
  - .3 Sigma
  - .4 Dunham-Bush

## **2.6 CABINET UNIT HEATERS (RECESSED IN WALL) (H-2)**

- .1 Cabinet: Recessed installation as indicated, 1.6 mm (16 gauge) thick steel with rounded exposed corners and edges, removable panels, glass fiber insulation and integral return air outlet and ducted supply air outlet, Arrangement 30.
- .2 Finish with factory applied primer coat.
- .3 Coils: aluminum fins mechanically bonded to copper tubes. Hydrostatically tested to 1 MPa (145 psi).
- .4 Fans: centrifugal double width wheels, statically and dynamically balanced, direct driven, sleeve bearings, resilient mounted.
- .5 Motor: multi-speed, tapped wound permanent split capacitor type with sleeve bearings, built-in thermal overload protection and resilient rubber isolation mounting.
- .6 Filters: removable permanent washable type.
- .7 Capacity and orientation as indicated.
- .8 Control:
  - .1 3 speed switch with integral overloads in cabinet.
  - .2 Control thermostat: by BAS contractor

- .9 Acceptable materials:
  - .1 Engineered Air CUH Series
  - .2 Slant Fin
  - .3 Sigma
  - .4 Dunham-Bush

## **2.7 HORIZONTAL UNIT HEATERS**

- .1 Casing: 1.6 mm (16 gauge) thick cold rolled steel, gloss enamel finish, with threaded connections for hanger rods.
- .2 Coils: seamless copper tubing, silver brazed to steel headers with evenly spaced aluminum fins mechanically bonded to tubing. Hydrostatically test to 1 MPa (145 psi).
- .3 Fan: direct drive propeller type, factory balanced, with anti-corrosive finish and fan guard.
- .4 Motor: speed as indicated continuous duty, built-in overload protection, and resilient motor supports.
- .5 Air outlet: two-way adjustable louvres.
- .6 Capacity: as indicated.
- .7 Control: room thermostat: electric, line voltage, locking cover, set point locking device, concealed adjustment, plastic cover. (By Building Automation Contractor).
- .8 Acceptable materials:
  - .1 Engineered Air H-Series
  - .2 Slant Fin
  - .3 Sigma
  - .4 Dunham-Bush

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install in accordance with manufacturer's instructions.
- .2 Install in accordance with piping layout and reviewed shop drawings.
- .3 Provide for pipe movement during normal operation.
- .4 Maintain sufficient clearance to permit performance of service maintenance.
- .5 Check final location with Consultant if different from that indicated prior to installation. Should deviations beyond allowable clearances arise, request and follow Consultant's directive.
- .6 Valves
  - .1 Install valves with stems upright or horizontal unless approved otherwise.
  - .2 Install isolating gate valves on inlet and balancing valves on outlet of each unit.



- .7 Venting:
  - .1 Install screwdriver vent on cabinet convector, terminating flush with surface of cabinet.
  - .2 Install standard air vent with cock on continuous finned tube radiation.
- .8 Clean finned tubes and comb straight.
- .9 Install flexible expansion compensators as indicated.
- .10 Mount wall mounted convectors at 200 mm (8") above finish floor.
- .11 Mount wall mounted radiation at 200 mm (8") above finish floor unless otherwise indicated.
- .12 **Thermostats on outside walls: mount on insulated backplates.**
- .13 On units fed from below floor provide factory manufactured piping shrouds on the exposed piping between base of the radiation cabinet and finished floor. Shroud shall be manufactured by the radiation manufacturer. Shroud shall match finish of the radiation cabinet.
- .14 **On fan forced units set discharge patterns and fan speeds to suit requirements prior to acceptance.**
- .15 **Provide new filter media.**

### 3.2 WARRANTY

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**

**Part 1            General**

**1.1            SHOP DRAWINGS**

- .1    Submit shop drawings in accordance with general requirements.
- .2    Indicate:
  - .1    Equipment, capacity, piping, and connections.
  - .2    Dimensions, construction details, recommended method of installation with proposed steel support.

**1.2            MAINTENANCE DATA**

- .1    Provide maintenance data for incorporation into manual specified in general requirements.

**1.3            SAMPLES**

- .1    Submit samples in accordance with general requirements.

**1.4            QUALITY ASSURANCE**

- .1    Panels shall be manufactured by a company regularly engaged in the manufacture of radiant panels and having catalogue performance data and certified test data.

**Part 2           Products**

**2.1            LINEAR RADIANT CEILING PANELS**

- .1    Contractor shall refer to architectural reflected ceiling plans and room finish schedule in addition to mechanical drawings to determine location, quantity and finish of radiant panels.
- .2    This panel specification is based on the AIRTEX HEF-2 Linear radiant ceiling panel design. Refer to the contract drawings for details and dimensions. Panels shall run continuously from wall to wall or as indicated and specified widths are minimum allowable.
- .3    Radiant ceiling extrusions shall consist of extruded aluminum with copper tubing of 15 mm (1/2") I.D. mechanically attached to the aluminum faceplate. The copper tube shall be held in place by an aluminum saddle, which extends more than half way around the diameter of the tube. A non-hardening heat conductive paste shall be placed between the copper tubing and the aluminum faceplate. Panels shall weigh no more than 10.5 kg/m<sup>2</sup> (2.15 lb/ft<sup>2</sup>) when operating. The use of adhesive and/or clips to attach the copper tube to the extrusion will not be acceptable.
- .4    Panels shall be finished in the manufacturer's standard white colour.
- .5    Acceptable materials:
  - .1    Airtex HEF-2
  - .2    Sigma

## **2.2 CAPACITY**

- .1 As indicated, based on 60°C (140°F) average water temperature, 11°C (20°F) temperature drop and 18.3C (65°F) E.A.T.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install in accordance with manufacturer's instructions and as indicated.
- .2 Install in accordance with piping layout and reviewed shop drawings.
- .3 Provide for pipe movement during normal operation.
- .4 Maintain sufficient clearance to permit performance of service maintenance.
- .5 Check final location with Consultant if different from that indicated prior to installation. Should deviations beyond allowable clearances arise, request and follow Consultant's directive.
- .6 The Mechanical Contractor shall co-operate with other trades working in the ceiling to achieve a neat, well co-ordinated overall installation. Refer to Architectural and Mechanical Details for installation requirements.
- .7 All interconnecting of radiant panels by the mechanical contractor shall consist of 0.500" O.D. soft copper tubing or accessories as recommended by the manufacturer, i.e. factory supplied 360 deg. Inter-connecting loops and 180 deg. Return U-bends. Multiple panels shall be circuited to ensure serpentine flow over complete length of zone. Individual serpentine panel coils connected in series are unacceptable for multiple panel zones.
- .8 All radiant panels shall be field trimmed to length ensuring adequate expansion allowance while maintaining panel end coverage by architectural mouldings. Inactive filler panels will be permitted only where indicated on drawings.
- .9 Ceiling support mouldings for Radiant Panels to be supplied and installed by general trades. Ensure ceiling openings and wall mouldings are installed as per radiant panel shop drawings.
- .10 All radiant panels shall be installed by personnel wearing clean white gloves, to avoid spoiling of panel face.
- .11 Provide hanger wires for safety and/or seismic restraint at 1.2 m (4'-0") o.c.
- .12 All active panels shall be covered with a minimum of 50 mm (2") foil backed thick batt non-combustible insulation. Seal edges/entire of perimeter of insulation to radiant panel with foil tape.

### **3.2 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.

- .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**

**Part 1 General**

**1.1 GENERAL**

- .1 This section is to read in conjunction with Division 1, the general condition, and the General Requirements of the mechanical trades.

**1.2 REFERENCES**

- .1 Tested to ANSI/UL Standard 508.
- .2 UL-508 certified for the building and assembly.
- .3 CSA or C-UL stickers shall be applied to both the VFD and option panels.
- .4 Manufacturers shall be ISO 9001 certified facilities.

**1.3 SUBMITTALS**

- .1 Submit manufacturer's performance data including dimensional drawings, power circuit diagrams, installation and maintenance manuals, warranty description, VFD's FLA rating, certification agency file numbers and catalogue information.
- .2 The specification lists the minimum VFD performance requirements for this project. Each supplier shall list any exceptions to the specification. If no departures from the specification are identified, the supplier shall be bound by the specification.
- .3 Harmonic filtering. The manufacturer shall, with the aid of the buyer's electrical power single line diagram, providing the data required by IEEE-519, perform an analysis to initially demonstrate the supplied equipment will meet the IEEE standards after installation. If, as a result of the analysis, it is determined that additional filter equipment is required to meet the IEEE recommendations, then the cost of such equipment shall be included in the bid. A harmonic analysis shall be submitted with the approval drawings to verify compliance with the latest version of IEEE-519 voltage and current distortion limits as shown in table 10.2 and 10.3 at the point of common coupling (PCC). The PCC shall be defined as the consumer-utility interface or primary side of the main distribution transformer.

**Part 2 Products**

**2.1 ACCEPTABLE MANUFACTURERS**

- .1 Danfoss Graham.
- .2 ABB.
- .3 AC Tech.

## 2.2 GENERAL

- .1 The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to eliminate the need for motor derating.
- .2 With the motor's rated voltage applied to the VFD input, the VFD shall allow the motor to produce full rated power at rated amps, RMS fundamental volts, and speed without using the motor's service factor. VFD's utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.
- .3 Include an input full-wave bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.
- .4 Provide DC link reactors on both the positive and negative rails of the DC bus to minimize power line harmonics. VFD's without DC link reactors shall provide a minimum 5% impedance line reactor.
- .5 Full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting.
- .6 Provide full torque at any selected frequency from 28 Hz to base speed to allow driving direct drive fans without derating.
- .7 An automatic energy optimization selection feature shall be provided in the VFD. This feature shall automatically and continually monitor the motor's speed and load and adjust the applied voltage to maximize energy savings and provide up to an additional 3% to 10% energy savings.
- .8 Input and output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD. Switching rate may be up to 1 time per minute on the input and unlimited on the output.
- .9 An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to run the test.
- .10 Galvanic and/or optical isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFD's not including either galvanic or optical isolation on both analog I/O and discrete I/O shall include additional isolation modules.
- .11 VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD efficiencies while reducing motor noise.
- .12 VFD's operating 600/3/60 motors not designed to meet Nema MG1 Part 31 should include Output dv/dt (LC) Reactors.

## **2.3 PROTECTIVE FEATURES**

- .1 VFD shall be provided with an integral disconnect and Integral Fast Blow Semi-Conductor fuses sized as specified by ULC. Fuses shall be Bussman JJS type or equivalent.
- .2 A minimum of Class 20 I2t electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications shall be provided.
- .3 Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over-voltage, under-voltage, VFD over-temperature and motor over-temperature. The VFD shall display all faults in plain English. Codes are not acceptable.
- .4 Protect VFD from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal.
- .5 The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.
- .6 To prevent breakdown of the motor winding insulation, the VFD shall be designed to comply with IEC Part 34-17. Motors shall have inverter rated insulation (1600V).
- .7 VFD shall include a "signal loss detection" circuit to sense the loss of an analog input signal such as 4 to 20 mA or 2 to 10 V DC, and shall be programmable to react as desired in such an instance.
- .8 VFD shall function normally when the keypad is removed while the VFD is running and continue to follow remote commands. No warnings or alarms shall be issued as a result of removing the keypad.
- .9 VFD shall catch a rotating motor operating forward or reverse up to full speed.
- .10 VFD shall be rated for 100,000 amp interrupting capacity (AIC).
- .11 VFD shall have externally mounted EMI electromagnetic suppressor to limit the EMI and RFI output from the VFD. VFD to be mounted in an all metal cabinet to limit radiated RFI.
- .12 VFD shall include current sensors on all three output phases to detect and report phase loss to the motor. The VFD will identify which of the output phases is low or lost.
- .13 VFD shall continue to operate without faulting until input voltage reaches 300 V AC on 208/230 volt VFD's, and 701V AC on 575 volt VFD's.
- .14 For remote VFD installations, provide an output filter (load side reactor) at each VFD to protect the equipment motor. Coordinate installation with equipment manufacturer.

## **2.4 INTERFACE FEATURES**

- .1 Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the VFD and determine the speed reference.
- .2 The VFD shall be able to be programmed to provide a 24 V DC output signal to indicate that the VFD is in Auto/Remote mode.
- .3 The VFD shall provide digital manual speed control. Potentiometers are not acceptable.

- 
- .4 Lockable, alphanumeric backlit display keypad can be remotely mounted up to 10 feet away using standard 9-pin cable.
  - .5 The keypads for all sizes of VFD's shall be identical and interchangeable.
  - .6 To set up multiple VFD's, it shall be possible to upload all set-up parameters to the VFD's keypad, place that keypad on all other VFD's in turn and download the set-up parameters to each VFD. To facilitate setting up VFD's of various sizes, it shall be possible to download from the keypad only size independent parameters.
  - .7 Display shall be programmable to display in 9 languages including English, Spanish and French.
  - .8 The display shall have four lines, with 20 characters on three lines and eight large characters on one line.
  - .9 A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.
  - .10 A quick set-up menu with factory preset typical HVAC parameters shall be provided on the VFD eliminating the need for macros.
  - .11 The VFD shall include a standard RS-485 communications port for connection to a Johnson Controls N2 and Siemens FLN serial communication system. The connection shall be software selectable and addressable by the user. The option for Lonworks and BacNet communication must also be available.
  - .12 As a minimum, the following points shall be controlled and/or accessible:  
VFD Start/Stop, Speed reference, Fault diagnostics, and Meter points as follows;  
Motor power in HP, Motor power in kW, Motor kW-hr, Motor current, Motor voltage, Hours run, Feedback signal #1, Feedback signal #2, DC link voltage, Thermal load on motor, and Thermal load on VFD, Heat sink temperature.
  - .13 Four additional Form C 230 volt programmable relays shall be available for factory or field installation within the VFD.
  - .14 Two set-point control interface (PID control) shall be standard in the unit. VFD shall be able to look at two feedback signals, compare with two set-points and make various process control decisions.
  - .15 Floating point control interface shall be provided to increase/decrease speed in response to contact closures.
  - .16 Four simultaneous displays shall be available. They shall include frequency or speed, run time, output amps and output power. VFD's unable to show these four displays simultaneously shall provide panel meters.
  - .17 Sleep mode shall be provided to automatically stop the VFD when its speed drops below set "sleep" level for a specified time. The VFD shall automatically restart when the speed command exceeds the set "wake" level.
  - .18 The sleep mode shall be functional in both follower mode and PID mode.



- .19 Run permissive circuit shall be provided to accept a “system ready” signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of sending an output signal as a start command to actuate external equipment before allowing the VFD to start.
- .20 The following displays shall be accessible from the control panel in actual units: Reference Signal Value in actual units, Output Frequency in Hz or percent, Output Amps, Motor HP, Motor kW, kWhr, Output Voltage, DC Bus Voltage, VFD Temperature in degrees, and Motor Speed in engineering units per application (in GPM, CFM, etc.). VFD will read out the selected engineering unit either in a linear, square or cubed relationship to output frequency as appropriate to the unit chosen.
- .21 The display shall be programmed to read in inches of water column (in-wg) for an air handler application, pressure per square inch (psi) for a pump application, and temperature (oF) for a cooling tower application.
- .22 VFD shall be able to be programmed to sense the loss of load and signal a no load/broken belt warning or fault.
- .23 If the temperature of the VFD’s heat sink rises to 80°C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. If the temperature of the heat sink continues to rise the VFD shall automatically reduce its output frequency to the motor. As the VFD’s heat sink temperature returns to normal, the VFD shall automatically increase the output frequency to the motor and return the carrier frequency to its normal switching speed.
- .24 The VFD shall have temperature controlled cooling fans for quiet operation and minimized losses.
- .25 The VFD shall store in memory the last 10 faults and related operational data.
- .26 Eight programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
- .27 Two programmable relay outputs, one Form C 240 V AC, one Form A 30 V AC, shall be provided for remote indication of VFD status.
- .28 Three programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include two voltage (0 to 10 V DC, 2 to 10 V DC) and one current (0 to 20 mA, 4 to 20 mA) input.
- .29 Two programmable 0 to 20 mA analog outputs shall be provided for indication of VFD status. These outputs shall be programmable for output speed, frequency, current and power. They shall also be programmable to provide a selected 24 V DC status indication.
- .30 Under fire mode conditions, the VFD shall be able to be programmed to automatically default to a preset speed.
- .31 A contact/relay shall be provided to shut the fans down upon fire alarm signal.

## 2.5 ADJUSTMENTS

- .1 VFD shall have an adjustable carrier frequency in steps of not less than 0.1 kHz to allow tuning the VFD to the motor.

- .2 Sixteen preset speeds shall be provided.
- .3 Four acceleration and four deceleration ramps shall be provided. Accel and decel time shall be adjustable over the range from 0 to 3,600 seconds to base speed. The shape of these curves shall be automatically contoured to ensure no-trip acceleration and deceleration.
- .4 Four current limit settings shall be provided.
- .5 If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: under-voltage, over-voltage, current limit and inverter overload.
- .6 The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.
- .7 An automatic “on delay” may be selected from 0 to 120 seconds.

## **2.6 SERVICE CONDITIONS**

- .1 Unit shall operate in ambient temperature of -10 to 40°C (14 to 104°F).
- .2 Unit shall operate in 0 to 95% relative humidity, non-condensing.
- .3 Operate in elevation up to 3,300 feet without derating.
- .4 Maximum AC line voltage variation, -10 to +10% of nominal with full output.
- .5 No side clearance shall be required for cooling of any units. All power and control wiring shall be done from the bottom.

## **2.7 FACTORY TESTING**

- .1 To ensure quality and minimize infantile failures at the jobsite, the manufacturer shall test the complete VFD. The VFD shall operate a dynamometer at full load and speed and shall be cycled during the test.
- .2 All optional features shall be functionally tested at the factory for proper operation.

## **2.8 BYPASS SWITCH**

- .1 Bypass Controller - Automatic transfer to line power via contactors. When in the “Drive” mode, the bypass contactor is open and the drive output contactor is closed. In the “Bypass” position, the drive output contactor is open, and the bypass contactor is closed via Start/stop command. Start/stop via customer supplied maintained contact shall be Dry type 115V compatible and shall function in both the “Drive” and “Bypass” modes. The design shall include single-phase protection in both the VFD and bypass modes.

---

**Part 3                    Execution**

**3.1                    START-UP SERVICE**

- .1        The manufacturer shall provide start-up and commissioning of the VFD and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. Sales personnel and other agents who are not factory certified shall not be acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system.

**3.2                    EXAMINATION**

- .1        Contractor to verify that job site conditions for installation meet factory recommended and code-required conditions for VFD installation prior to start-up, including clearance spacing, temperature, contamination, dust, and moisture of the environment. Separate conduit installation of the motor wiring, power wiring, and control wiring, and installation per the manufacturer's recommendations shall be verified.

**3.3                    INSTALLATION**

- .1        Install to manufacturer's recommendations.
- .2        Install to the requirements of the local Hydro codes. Obtain hydro permits and pay all fees.
- .3        Install in an accessible location and proper service height from floor.
- .4        Install in clean, dry, and conditioned environment.
- .5        The VFD is to be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD shall not be operated while the unit is covered.
- .6        Wiring of devices to be to the standards of Electrical Division.
- .7        Provide one manufacturer of VFDs throughout the project.

**3.4                    WARRANTY**

- .1        Warranty Start Date:
  - .1        Warranty period starts as of the date of Ready for Takeover.
  - .2        Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2        Warranty Duration:
  - .1        The VFD shall be warranted by the manufacturer for a period of five (5) years from date of Ready for Takeover. The warranty shall include parts, labour, travel costs and living expenses incurred by the manufacturer to provide factory authorized on-site service. The warranty shall be provided by the VFD manufacturer.

**END OF SECTION**

---

**Section 25 20 11**  
**Building Automation System**

**Hamilton-Wentworth District School Board**

**Controls Specification**

---

---

# Contents

Contents.....	2
PART 1 GENERAL.....	4
1.1 Products Furnished But Not Installed Under This Section .....	5
1.2 Products Installed But Not Furnished Under This Section .....	5
1.3 Products Not Furnished or Installed but integrated with the Work of this Section .....	5
1.4 Related Sections.....	6
1.5 Description.....	6
1.6 Approved Control Systems .....	7
1.7 Quality Assurance .....	7
1.8 Codes And Standards.....	7
1.9 System Performance.....	7
1.10 Submittals .....	10
1.11 Warranty .....	12
1.12 Ownership Of Proprietary Material.....	13
PART 2 PRODUCTS.....	14
2.1 Materials .....	15
2.2 Communication.....	15
2.3 Operator Interface .....	16
2.4 Controller Software .....	21
2.5 Controllers .....	22
2.6 Input and Output Interface.....	24
2.7 Power Supplies And Line Filtering .....	25
2.8 Auxiliary Control Devices .....	25
2.9 Wiring And Raceways .....	29
Part 3 EXECUTION .....	30
3.1 Examination .....	31
3.2 Protection .....	31
3.3 Coordination .....	31
3.4 General Workmanship.....	32
3.5 Field Quality Control .....	32
3.6 Wiring.....	32
3.7 Communication Wiring.....	34
3.8 Installation of Sensors.....	34
3.9 Flow Switch Installation .....	35
3.10 Actuators.....	35
3.11 Warning Labels .....	35
3.12 Identification of Hardware and Wiring.....	36
3.13 Programming .....	36
3.14 Control System Checkout and Testing.....	37
3.15 Control System Demonstration and Acceptance.....	37
3.16 Cleaning .....	38
3.17 Training .....	38
APPENDIX A SEQUENCES OF OPERATION.....	40
.1 Hot Water Boiler System .....	40
.2 HVAC General .....	42
.3 VAV Unit Operation .....	43

.4	Exhaust Fans .....	46
.5	Schneider Electric PowerLogic PM5560 Digital Metering System.....	47
.6	Domestic Hot Water Systems .....	48
.7	Radiation And/Or Radiant Panels .....	48
.8	Lighting Control.....	49
.9	Cabinet Unit Heaters & Horizontal Unit Heaters.....	49
.10	VAV Terminal with Reheat.....	50
.11	Control Valve Exercising .....	52
.12	Mechanical Room Control .....	52
.13	Phase Loss Detection .....	53
.14	BAS-To-Security Panel.....	53
.15	Main Gas & Water Consumption Metering.....	53
.16	Fire Alarm Panel.....	53
.17	Library Destratification Fan (Gym Similar).....	54
.18	Individual Room Control (Reheat Coil) .....	54
APPENDIX B	GLOSSARY OF TERMS .....	55
1.1	Terms used within the Specification Text.....	55
1.2	Terms used within the Sequences of Operation .....	56
1.3	Contracting Terms.....	58
APPENDIX C	ABBREVIATIONS .....	59
APPENDIX D	POINTS LIST .....	61

## **PART 1      GENERAL**

### **Section Includes:**

- 1.1      Products Furnished but not Installed Under this Section**
- 1.2      Products Installed but not Furnished Under this Section**
- 1.3      Products not Furnished or Installed but Integrated with the Work of this Section**
- 1.4      Related Sections**
- 1.5      Description**
- 1.6      Approved Control Systems**
- 1.7      Quality Assurance**
- 1.8      Codes and Standards**
- 1.9      System Performance**
- 1.10    Submittals**
- 1.11    Warranty**
- 1.12    Ownership of Proprietary Material**

### **1.1 Products Furnished But Not Installed Under This Section**

1. Control valves
2. Pressure sensor wells & sockets
3. Temperature sensor wells & sockets
4. Control dampers

### **1.2 Products Installed But Not Furnished Under This Section**

None

### **1.3 Products Not Furnished or Installed but integrated with the Work of this Section**

#### **A. General:**

1. Coordination Meeting: The Installer furnishing the DDC network shall meet with the Installer(s) furnishing each of the following products to coordinate details of the interface between these products and the DDC network. The Owner or his designated representative shall be present at this meeting. Each Installer shall provide the Owner and all other Installers with details of the proposed interface including PICS for BACnet equipment, hardware and software identifiers for the interface points, network identifiers, wiring requirements, communication speeds, and required network accessories. The purpose of this meeting shall be to insure there are no unresolved issues regarding the integration of these products into the DDC network. Submittals for these products shall not be approved prior to the completion of this meeting.

#### **B. Lighting, Security and Fire Alarm:**

1. Lighting Control System, Security & Fire Alarm Systems
2. BAS to control all corridor and exterior lights ON/OFF based off security panel output through a H/A/O (Hand/Auto/Off) contactor.

#### **C. Integration:**

1. Computerized Maintenance Management System

#### **D. Domestic Water System:**

1. Domestic Water System controls: The system vendor shall furnish a system with an interface to the control and monitoring points specified in Appendix A. These specified points shall be the minimum acceptable interface to the system. The connection to these points shall be by one of the following methods: (a) BACnet/IP network connection. (b) BACnet over ARCNET network connection. (c) BACnet MS/TP network connection

#### **E. Boiler System:**

1. Boiler controls: Unit shall be furnished configured to accept control inputs from an external building automation system controller as specified in Appendix A. Factory mounted safeties and other controls shall not interfere with this controller. The boiler control shall be through hardwired points (0-10 VDC) signal for control of firing rate and enable/disable). Boiler run status and boiler alarm points shall be hardwired points to the BAS system. In addition the boilers shall be interfaced to the BAS system through the BACnet module to monitor all other available points (boiler run time, flue temperature, heat exchanger temperature, service required, indicator, and all other diagnostic information). Monitoring of points as specified in Appendix A points shall be by one of the following methods: (a) BACnet/IP network connection. (b) BACnet over ARCNET network connection. (c) BACnet MS/TP network connection

#### **F. HVAC/ERV Units:**

1. HVAC/ERV unit controls: Unit shall be furnished configured to accept control inputs from an external building automation system controller (hardwired points) as specified in Appendix A. Factory mounted safeties and other controls shall not interfere with this controller.



G. Terminal Heating and Cooling Unit:

1. Cabinet heaters, unit heaters, etc.: Unit heaters, cabinet heaters, convective or fin tube heaters, zone reheat, and similar terminal units: These units shall be furnished configured to accept control inputs from an external building automation system controller as specified in Appendix A. Factory mounted safeties and other controls shall not interfere with this controller.

H. Static Power Equipment:

1. Variable frequency drives: The variable frequency drive (VFD) vendor shall furnish VFDs with an interface to the control and monitoring points specified in Appendix A. These specified points shall be the minimum acceptable interface to the VFD. The connection to these points shall be by the following methods: (a) Hardwired connection such as relay, 0-10VDC, or 4-20mA and (b) BACnet/IP network connection. (c) BACnet MS/TP network connection.

I. Communications with Third Party Equipment:

1. Any additional integral control systems included with the products integrated with the work of this section shall be furnished with a BACnet interface for integration into the Direct Digital Control System described in this section. The only exception to this would be for any digital metering system interfaces, which can also be connected to via a Modbus connection. Open system protocol shall be maintained, and no proprietary equipment will be allowed to successfully complete any third party integrations. The controls contractor is responsible for all programming necessary to seamlessly integrate this third party equipment to the BAS. The controls contractor is responsible for providing device addresses for all devices that are going to be integrated to the BAS, such that no device communication issues will arise. The controls contractor is responsible for any meetings, correspondence or communication required with the third party equipment suppliers in order to successfully integrate the equipment to the BAS.

## 1.4 Related Sections

- A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are part of this specification and shall be used in conjunction with this section as part of the contract documents.

## 1.5 Description

- A. General: The control system shall consist of a high-speed, peer-to-peer network of DDC controllers and a web-based operator interface. Depict each system and building floor plan by a point-and-click graphic. All graphics shall be created using a background template, approved by the board, and shall be derived from a Microsoft Visio file (.vsx). Please submit samples of the graphics with the shop drawing submittal for review and approved by HWDSB. A web server with a network interface card shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface.
- B. The system shall directly control HVAC equipment as specified in Section 25 20 11 Appendix A (Sequences of Operation). Each zone controller shall provide occupied and unoccupied modes of operation by individual zone. Furnish energy conservation features such as optimal start and stop, night setback, request-based logic, and demand level adjustment of setpoints as specified in Appendix A.
- C. Provide for future system expansion to include integration to occupant card access systems, CCTV systems, fire alarm systems, security systems, computerized maintenance management systems, event management systems and lighting control systems.
- D. System shall use the BACnet protocol for communication to the operator workstation or web server and for communication between control modules. Schedules, setpoints, trends, and alarms specified in Section 25 20 11 Appendix A (Sequences of Operation) shall be BACnet objects.

## 1.6 Approved Control Systems

- A. The following are approved control system suppliers, manufacturers, and product lines:

Supplier	Manufacturer	Product Line
Siemens	Siemens	Apogee

- B. The above list does not indicate order of preference. Inclusion on this list does not guarantee acceptance of products or installation. Control systems shall comply with the terms of this specification.
1. The Contractor shall use only controller software, custom application programming language, and controllers from the corresponding manufacturer and product line unless Owner approves use of multiple manufacturers.
  2. Other products specified herein (such as sensors, valves, dampers, and actuators) need not be manufactured by the above manufacturers.

## 1.7 Quality Assurance

- A. Installer and Manufacturer Qualifications
1. Installer shall have an established working relationship with Control System Manufacturer.
  2. Installer shall have successfully completed Control System Manufacturer's control system training. Upon request, Installer shall present record of completed training including course outlines.

## 1.8 Codes And Standards

- A. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with current editions in effect 30 days prior to receipt of bids of the following codes:
1. National Electric Code (NEC) and applicable local Electric Code
  2. National Fire Protection Association (NFPA) standards; including NFPA 70, NFPA 90A and NFPA 92A & 92B
  3. Underwriters Laboratories (UL) listing and labels
  4. American National Standards Institute (ANSI)
  5. National Electric Manufacturer's Association (NEMA)
  6. American Society of Mechanical Engineers (ASME)
  7. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE); including ASHRAE 195-2004 (BACnet)
  8. Air Movement and Control Association (AMCA)
  9. Institute of Electrical and Electronic Engineers (IEEE)
  10. American Standard Code for Information Interchange (ASCII)
  11. Electronics Industries Association (EIA)
  12. Occupational Safety and Health Administration (OSHA)
  13. American Society for Testing and Materials (ASTM)
  14. Federal Communications Commission (FCC); including Part 15 – Radio Frequency Devices

## 1.9 System Performance

- A. Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation (server and browser for web-based systems).
1. Graphic Display. A graphic with 20 dynamic points shall display with current data within 10 sec.

2. Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 sec. and shall automatically refresh every 15 sec.
3. Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.
4. Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.
5. Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 15 sec.
6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 sec. Select execution times consistent with the mechanical process under control.
7. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per second. Select execution times consistent with the mechanical process under control.
8. Reporting Accuracy. System shall report values with minimum end-to-end accuracy listed in Table 1.
9. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2.

**Table 1**  
**Reporting Accuracy**

Measured Variable	Reported Accuracy
Space Temperature	±0.5°C (±1°F)
Ducted Air	±0.5°C (±1°F)
Outside Air	±1.0°C (±2°F)
Dew Point	±1.5°C (±3°F)
Water Temperature	±0.5°C (±1°F)
Delta-T	±0.15°C (±0.25°F)
Relative Humidity	±5% RH
Water Flow	±2% of full scale
Airflow (terminal)	±10% of full scale (see Note 1)
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized spaces)	±3% of full scale
Air Pressure (ducts)	±25 Pa (±0.1 in. w.g.)
Air Pressure (space)	±3 Pa (±0.01 in. w.g.)
Water Pressure	±2% of full scale (see Note 2)
Electrical (A, V, W, Power Factor)	±1% of reading (see Note 3)
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO <sub>2</sub> )	±50 ppm

**Note 1: Accuracy applies to 10% - 100% of scale**

**Note 2: For both absolute and differential pressure**

**Note 3: Not including utility-supplied meters**

**Table 2**  
**Control Stability and Accuracy**

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±50 Pa (±0.2 in. w.g.) ±3 Pa (±0.01 in. w.g.)	0-1.5 kPa (0-6 in. w.g.) -25 to 25 Pa (-0.1 to 0.1 in. w.g.)
Airflow	±10% of full scale	
Space Temperature	±1.0°C (±2.0°F)	
Duct Temperature	±1.5°C (±3°F)	
Humidity	±5% RH	
Fluid Pressure	±10 kPa (±1.5 psi) ±250 Pa (±1.0 in. w.g.)	MPa (1-150 psi) 0-12.5 kPa (0-50 in. w.g.) differential

## 1.10 Submittals

- A. Product Submittal Requirements: Meet specification requirements for all Shop Drawings, Product Data, and Samples. Provide six copies of shop drawings and other submittals on hardware, software, and equipment to be installed or furnished. Begin no work until submittals have been approved for conformity with design intent. Provide drawings as Microsoft Visio files on magnetic or optical disk (file format: .VSD or comparable) and 3 prints of each drawing on 11" x 17" paper. When manufacturer's cutsheets apply to a product series rather than a specific product, clearly indicate applicable data by highlighting or by other means. Clearly reference covered specification and drawing on each submittal. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Submittal approval does not relieve Contractor of responsibility to supply sufficient quantities to complete work. Provide submittals within 12 weeks of contract award on the following:

1. Direct Digital Control System Hardware
  - a. Complete bill of materials indicating quantity, manufacturer, model number, and relevant technical data of equipment to be used.
  - b. Manufacturer's description and technical data such as performance curves, product specifications, and installation and maintenance instructions for items listed below and for relevant items not listed below:
    - i. Direct digital controllers (controller panels)
    - ii. Transducers and transmitters
    - iii. Sensors (include accuracy data)
    - iv. Actuators
    - v. Valves
    - vi. Relays and switches
    - vii. Control panels
    - viii. Power supplies
    - ix. Batteries
    - x. Operator interface equipment
    - xi. Wiring
  - c. Wiring diagrams and layouts for each control panel. Show termination numbers.
  - d. Floor plan schematic diagrams indicating field sensor and controller locations.
  - e. Riser diagrams showing control network layout, communication protocol, and wire types.
2. Central System Hardware and Software
  - a. Complete bill of material indicating quantity, manufacturer, model number, and relevant technical data of equipment used.
  - b. Manufacturer's description and technical data such as product specifications and installation and maintenance instructions for items listed below and for relevant items furnished under this contract not listed below:
    - i. Central Processing Unit (CPU) or web server
    - ii. Monitors
    - iii. Keyboards
    - iv. Power supplies
    - v. Battery backups
    - vi. Interface equipment between CPU or server and control panels
    - vii. Operating System software
    - viii. Operator interface software
    - ix. Color graphic software
    - x. Third-party software
  - c. Schematic diagrams of control, communication, and power wiring for central system installation. Show interface wiring to control system.

- d. Network riser diagrams of wiring between central control unit and control panels.
- 3. Controlled Systems
  - a. Riser diagrams showing control network layout, communication protocol, and wire types.
  - b. Schematic diagram of each controlled system. Label control points with point names. Graphically show locations of control elements.
  - c. Schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
  - d. Instrumentation list (Bill of Materials) for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
  - e. Complete description of control system operation including sequences of operation. Include and reference schematic diagram of controlled system. List I/O points and software points specified in Section 25 20 11 Appendix A. Indicate alarmed and trended points, complete with alarm values and trend sample quantities and sample intervals.
- 4. Description of process, report formats, and checklists to be used in Section 25 20 11 Article 3.16 (Control System Demonstration and Acceptance).
- 5. BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of controller and operator interface.

**B. Schedules**

- 1. Schedule of work provided within one month of contract award, indicating:
  - a. Intended sequence of work items
  - b. Start date of each work item
  - c. Duration of each work item
  - d. Planned delivery dates for ordered material and equipment and expected lead times
  - e. Milestones indicating possible restraints on work by other trades or situations
- 2. Monthly written status reports indicating work completed and revisions to expected delivery dates. Include updated schedule of work.

**C. Project Record Documents. Submit three copies of record (as-built) documents upon completion of installation for approval prior to final completion. Submittal shall consist of:**

- 1. Project Record Drawings. As-built versions of submittal shop drawings provided as Microsoft Visio files on magnetic or optical disk (file format: .VSD or comparable) and 6 prints of each drawing on 11" x 17" paper. As-built sequences of operation shall include any and all approved control changes made during the course of the project. All equipment schedule start and end times shall be included in the as-built drawings. All control setpoints shall be included in the as-built drawings. The BAS controller network riser diagrams shall be accurate and indicative of the actual installation.
- 2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of Section 25 20 11 Article 3.16 (Control System Demonstration and Acceptance).
- 3. Operation and Maintenance (O&M) Manual. Printed documentation of the following:
  - a. As-built versions of submittal product data.
  - b. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
  - c. Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
  - d. Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.

- e. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
  - f. Documentation of programs created using custom programming language including setpoints, tuning parameters, and object database. Electronic copies of programs shall meet this requirement if control logic, setpoints, tuning parameters, and objects can be viewed using furnished programming tools.
  - g. Graphic files, programs, and database on magnetic or optical media.
  - h. List of recommended spare parts with part numbers and suppliers.
  - i. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
  - j. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation or web server software, and graphics software.
  - k. Licenses, guarantees, and warranty documents for equipment and systems.
  - l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
- D. Training Materials: Provide course outline and materials for each class at least six weeks before first class. Training shall be furnished via instructor-led sessions, computer-based training, or web-based training. Engineer will modify course outlines and materials if necessary to meet Owner's needs. Engineer will review and approve course outlines and materials at least three weeks before first class.

#### **1.11 Warranty**

- A. Warrant work as follows:
- 1. Warrant labor and materials for specified control system free from defects for a period of 24 months after final acceptance. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner's warranty service request.
  - 2. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.
  - 3. If Engineer determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, Engineer will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.
  - 4. Provide updates to operator workstation or web server software, project-specific software, graphic software, database software, and firmware that resolve Contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.
  - 5. Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer's acceptance.

## **1.12 Ownership Of Proprietary Material**

- A. Project-specific software and documentation shall become Owner's property. This includes, but is not limited to:
1. Graphics
  2. Record drawings
  3. Database
  4. Application programming code
  5. Documentation



## **PART 2: PRODUCTS**

### **Section Includes**

- 2.1 Materials**
- 2.2 Communication**
- 2.3 Operator Interface**
- 2.4 Controller Software**
- 2.5 Controllers**
- 2.6 Input and Output Interface**
- 2.7 Power Supplies and Line Filtering**
- 2.8 Auxiliary Control Devices**
- 2.9 Wiring and Raceways**

## **2.1 Materials**

- A. Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts shall be available for at least seven (7) years after completion of this contract.

## **2.2 Communication**

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.
- B. Install new wiring and network devices as required to provide a complete and workable control network. Remote buildings or sites to be connected to through the Board's existing Ethernet network. In each remote location, an Ethernet network and field device connection shall allow communication with each controller on the internetwork as specified in Paragraph D.
- C. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations. The owner shall be supplied with the required interface software to achieve this.
- D. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
  - 1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
  - 2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified in Section 25 20 11 Appendix A. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.
- E. Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated controller via the internetwork. System shall automatically adjust for daylight saving and standard time changes.
- F. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.
- G. System shall support Web services data exchange with any other system that complies with XML (extensible markup language) and SOAP (simple object access protocol) standards specified by the Web Services Interoperability Organization (WS-I) Basic Profile 1.0 or higher. Web services support shall as a minimum be provided at the workstation or web server level and shall enable data to be read from or written to the system.
  - 1. System shall support Web services read data requests by retrieving requested trend data or point values (I/O hardware points, analog value software points, or binary value software points) from any system controller or from the trend history database.
  - 2. System shall support Web services write data request to each analog and binary object that can be edited through the system operator interface by downloading a numeric value to the specified object.
  - 3. For read or write requests, the system shall require user name and password authentication and shall support SSL (Secure Socket Layer) or equivalent data encryption.
  - 4. System shall support discovery through a Web services connection or shall provide a tool available through the Operator Interface that will reveal the path/identifier needed to allow a third party Web services device to read data from or write data to any object in the system which supports this service.

## 2.3 Operator Interface

- A. Operator Interface. Web server shall reside on high-speed network with building controllers. Each standard browser connected to server shall be able to access all system information. In addition to the primary operator interface, the system shall include a secondary interface compatible with a locally available commercial wireless network and viewable on a commercially available wireless device such as a Wireless Access Protocol (WAP) enabled cellular telephone or personal digital assistant (PDA). This secondary interface may be text-based and shall provide a summary of the most important data. As a minimum, the following capabilities shall be provided through this interface:
  - 1. An operator authentication system that requires an operator to log in before viewing or editing any data, and which can be configured to limit the privileges of an individual operator.
  - 2. The ability to view and acknowledge any alarm in the system. Alarms or links to alarms shall be provided on a contiguous list so the operator can quickly view all alarms.
  - 3. A summary page or pages for each piece of equipment in the system. This page shall include the current values of all critical I/O points and shall allow the operator to lock binary points on or off and to lock analog points to any value within their range.
  - 4. Navigation links that allow the operator to quickly navigate from the home screen to any piece of equipment in the system, and then return to the home screen. These links may be arranged in a hierarchical fashion, such as navigating from the home screen to a particular building, then to a specific floor in the building, and then to a specific room or piece of equipment.
- B. Communication. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135, BACnet Annex J.
- C. Hardware. Each BAS workstation machine shall be provided by the board.
- D. Operator Functions. Operator interface shall allow each authorized operator to execute the following functions as a minimum:
  - 1. Log In and Log Out. System shall require user name and password to log in to operator interface.
  - 2. Point-and-click Navigation. Operator interface shall be graphically based and shall allow operators to access graphics for equipment and geographic areas using point-and-click navigation.
  - 3. View and Adjust Equipment Properties. Operators shall be able to view controlled equipment status and to adjust operating parameters such as setpoints, PID gains, on and off controls, and sensor calibration.
  - 4. View and Adjust Operating Schedules. Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. System shall clearly show exception schedules and holidays on the schedule display. A universal schedule point shall also be available. The following schedules shall be set up by the BAS contractor: a normal base school day schedule, a summer schedule, a schedule for the last week of August, and a heating schedule to be used for Christmas Break & March Break. A statutory holiday exclusion schedule shall be set up as well. All of these various schedules shall be linked to a calendar object.
  - 5. View and Respond to Alarms. Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm, and to clear (delete) unneeded alarms. All alarm extensions, as shown in the point schedule, shall be setup with the correct parameters as part of this project.
  - 6. View and Configure Trends. Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time period or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points. All trend extensions, as shown in the point schedule, shall be setup with the correct parameters as part of this project.

7. View and Configure Reports. Operators shall be able to run preconfigured reports, to view report results, and to customize report configuration to show data of interest.
  8. Manage Control System Hardware. Operators shall be able to view controller status, to restart (reboot) each controller, and to download new control software to each controller.
  9. Manage Operator Access. Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators, and to edit operator function authorization. Operator shall be able to authorize each operator function separately.
- E. System Software.
1. Operating System. Web server shall have an industry-standard professional-grade operating system. Acceptable systems include Microsoft Windows 7, Vista or Windows XP Pro.
  2. System Graphics. Operator interface shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract.
    - a. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.
    - b. Animation. Graphics shall be able to animate by displaying different image files for changed object status.
    - c. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
    - d. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. The graphics background images shall be created from a Microsoft Visio file. The layout of the graphics background images shall be as per standard graphics library files provided by the Owner. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require only widely available no-cost plug-ins (such as Active-X, Adobe Flash and JavaScript).
- F. System Tools. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard IBM-compatible PCs with no limit on the number of copies that can be installed under the system license.
1. Automatic System Database Configuration. Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
  2. Controller Memory Download. Operators shall be able to download memory from the system database to each controller.
  3. System Configuration. Operators shall be able to configure the system.
  4. Online Help. Context-sensitive online help for each tool shall assist operators in operating and editing the system.
  5. Security. System shall require a user name and password to view, edit, add, or delete data.
    - a. Operator Access. Each user name and password combination shall define accessible viewing, editing, adding, and deleting functions in each system application, editor, and object. Authorized operators shall be able to vary and deny each operator's accessible functions based on equipment or geographic location.

- b. Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. Operators shall be able to adjust automatic log out delay.
  - c. Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.
- 6. System Diagnostics. System shall automatically monitor controller and I/O point operation. System shall annunciate controller failure and I/O point locking (manual overriding to a fixed value).
- 7. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Section 25 20 11 Appendix A (Sequences of Operation) and point schedule. Alarms shall be BACnet alarm objects and shall use BACnet alarm services. Alarm low and high levels for each point which shall have an alarm (see BAS Point List) shall be approved of by the Board prior to implementation.
- 8. Alarm Messages. Alarm messages shall use an English language descriptor without acronyms or mnemonics to describe alarm source, location, and nature.
- 9. Alarm Reactions. Operator shall be able to configure (by object) actions workstation or web server shall initiate on receipt of each alarm. As a minimum, workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.
- 10. Alarm Maintenance. Operators shall be able to view system alarms and changes of state chronologically, to acknowledge and delete alarms, and to archive closed alarms to the workstation or web server hard disk from each workstation or web browser interface.
- 11. Trend Configuration. Operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified in Section 25 20 11 Appendix A (Sequences of Operation) and point schedule. Trends shall be BACnet trend objects and shall have meaningful, descriptive naming. Trend sample times and number of samples for each point which shall have a trend (see BAS Point List) shall be approved of by the Board prior to implementation.
- 12. Object and Property Status and Control. Operator shall be able to view, and to edit if applicable, the status of each system object and property by menu, on graphics, or through custom programs.
- 13. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
- 14. Standard Reports. Furnish the following standard system reports:
  - a. Objects. System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.
  - b. Alarm Summary. Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.
  - c. Logs. System shall log the following to a database or text file and shall retain data for an adjustable period:
    - i. Alarm History.
    - ii. Trend Data. Operator shall be able to select trends to be logged.
    - iii. Operator Activity. At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes, and alarm acknowledgment and deletion. System shall date and time stamp logged activity.

15. Energy Reports. System shall include an easily configured energy reporting tool that provides the capabilities described in this section.
- a. The energy reporting tool shall be accessible through the same user interface (Web browser or operator workstation software) as is used to manage the BAS.
  - b. The energy reporting tool shall be preconfigured by the Contractor to gather and store energy demand and consumption data from each energy source that provides metered data to the BAS. Meter data shall be stored at 5 minute intervals unless otherwise specified in the Sequence of Operation provided in Appendix A. This data shall be maintained in an industry standard SQL database for a period of not less than five years.
  - c. The energy reporting tool shall allow the operator to select an energy source and a time period of interest (day, week, month, year, or date range) and shall provide options to view the data in a table, line graph, bar graph, or pie chart. The tool shall also allow the operator to select two or more data sources and display a comparison of the energy used over this period in any of the listed graph formats, or to total the energy used by the selected sources and display that data in the supported formats.
  - d. The energy reporting tool shall allow the operator to select an energy source and two time periods of interest (day, week, month, year, or date range) and display a graph that compares the energy use over the two time periods in any of the graph formats listed in the previous paragraph. The tool shall also allow the operator to select multiple energy sources and display a graph that compares the total energy used by these sources over the two time periods.
  - e. The energy reporting tool shall allow the operator to easily generate the previously described graphs "on the fly," and shall provide an option to store the report format so the operator can select that format to regenerate the graph at a future date. The tool shall also allow the user to schedule these reports to run on a recurring basis using relative time periods, such as automatically generating a consumption report on the first Monday of each month showing consumption over the previous month. Automatically generated reports shall be archived on the server in a common industry format such as Adobe PDF or Microsoft Excel with copies e-mailed to a user editable list of recipients.
  - f. The energy reporting tool shall be capable of collecting and displaying data from the following types of meters:
    - i. Electricity
    - ii. Gas
    - iii. Heating Water
    - iv. Potable Water
    - v. Heating and cooling degree days. (May be calculated from sensor data rather than metered.)
  - g. The user shall have the option of using Kw (Kwh) or Btu/hr (Btu) as the units for demand and consumption reports. Multiples of these units (MWH, kBtu, etc.) shall be used as appropriate. All selected sources shall be automatically converted to the selected units. The user shall similarly have the option of entering facility area and occupancy hours and creating reports that are normalized on an area basis, an annual use basis, or an occupied hour basis.
  - h. The user shall have the option of entering benchmark data for an individual facility or a group of facilities.
  - j. The user shall have the option of displaying any or all of the following data on any chart, line, or bar graph generated by the energy reporting tool:
    - i. Low/High/Average value of the metered value being displayed.
    - ii. Heating and/or Cooling Degree Days for the time period(s) being displayed.
    - iii. The Environmental Index for the facilities and time periods being displayed.

16. Environmental Index. System shall monitor all occupied zones and compile an index that provides a numerical indication of the environmental comfort within the zone. As a minimum, this indication shall be based upon the deviation of the zone temperature from the heating or cooling setpoint. If humidity is being measured within the zone then the environmental index shall be adjusted to reflect a lower comfort level for high or low humidity levels. Similarly, if carbon dioxide levels are being measured as an indication of ventilation effectiveness then the environmental index shall be adjusted to indicate degraded comfort at high carbon dioxide levels. Other adjustments may be made to the environmental index based upon additional measurements. The system shall maintain a trend of the environmental index for each zone in the trend log. The system shall also compute an average comfort index for every building included in this contract and maintain trend logs of these building environmental indices. Similarly, the system shall compute the percentage of occupied time that comfortable conditions were maintained within the zones. Through the UI the user shall be able to add a weighting factor to adjust the contribution of each zone to the average index based upon the floor area of the zone, importance of the zone, or other static criteria.
17. Custom Reports. Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations, and that present results in tabular or graphical format. Reports shall be launched from the operator interface.
18. Graphics Generation. Graphically based tools and documentation shall allow Operator to edit system graphics, to create graphics, and to integrate graphics into the system. Operator shall be able to add analog and binary values, dynamic text, static text, and animation files to a background graphic using a mouse. The background graphic is to be a Microsoft Visio (.VSD) file.
19. Graphics Library. Complete library of standard HVAC equipment graphics shall include equipment such as chillers, boilers, air handlers, heat pumps, terminal units, fan coils, and unit ventilators. Library shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. Library graphic file format shall be Microsoft Visio (.VSD) format and shall be compatible with graphics generation tools. The layout of the graphics background images shall be as per standard graphics library files provided by the Owner.
20. Custom Application Programming. Operator shall be able to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language shall have the following features:
  - a. Language. Language is preferred to be graphically based and shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks.
  - b. Programming Environment. Tool shall provide a full-screen, cursor-and-mouse-driven programming environment that incorporates word processing features such as cut and paste. Operators shall be able to insert, add, modify, and delete custom programming code, and to copy blocks of code to a file library for reuse in other control programs.
  - c. Independent Program Modules. Operator shall be able to develop independently executing program modules that can disable, enable and exchange data with other program modules.
  - d. Debugging and Simulation. Operator shall be able to step through the program observing intermediate values and results. Operator shall be able to adjust input variables to simulate actual operating conditions. Operator shall be able to adjust each step's time increment to observe operation of delays, integrators, and other time-sensitive control logic. Debugger shall provide error messages for syntax and for execution errors.

- e. Conditional Statements. Operator shall be able to program conditional logic using compound Boolean (AND, OR, and NOT) and relational (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
- f. Mathematical Functions. Language shall support floating-point addition, subtraction, multiplication, division, and square root operations, as well as absolute value calculation and programmatic selection of minimum and maximum values from a list of values.
- g. Variables: Operator shall be able to use variable values in program conditional statements and mathematical functions.
  - i. Time Variables. Operator shall be able to use predefined variables to represent time of day, day of the week, month of the year, and date. Other predefined variables or simple control logic shall provide elapsed time in seconds, minutes, hours, and days. Operator shall be able to start, stop, and reset elapsed time variables using the program language.
  - ii. System Variables. Operator shall be able to use predefined variables to represent status and results of Controller Software and shall be able to enable, disable, and change setpoints of Controller Software as described in Controller Software section.
- G. Portable Operator's Terminal. Provide all necessary software to configure an IBM-compatible laptop computer for use as a Portable Operator's Terminal. Operator shall be able to connect configured Terminal to the system network or directly to each controller for programming, setting up, and troubleshooting.
- H. Operator Workstation: Web server or workstation shall conform to BACnet Operator Workstation (B-OWS) device profile or BACnet Advanced Workstation (B-AWS) as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-OWS or B-AWS in the BACnet Testing Laboratories (BTL) Product Listing.

## **2.4 Controller Software**

- A. Building and energy management application software shall reside and operate in system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.
- B. System Security. See Paragraph 2.3.F.5 (Security) and Paragraph 2.3.F.15.c (Operator Activity).
- C. Scheduling. See Paragraph 2.3.D.4 (View and Adjust Operating Schedules). System shall provide the following schedule options as a minimum:
  - 1. Weekly. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
  - 2. Exception. Operator shall be able to designate an exception schedule for each of the next 365 days. After an exception schedule has executed, system shall discard and replace exception schedule with standard schedule for that day of the week.
  - 3. Holiday. Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.
  - 4. Master. Operator shall be able to modify master schedules created by the controls contractor. These master schedules shall put all applicable equipment into "unoccupied" mode during school "off" times (i.e. summer break, March break, Christmas break, snow days, etc.). The contractor shall work with the Owner to setup these master schedules as part of this project.
- D. System Coordination. Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.
- E. Binary and Analog Alarms. See Paragraph 2.3.F.7 (Alarm Processing).
- F. Alarm Reporting. See Paragraph 2.3.F.9 (Alarm Reactions).
- G. Remote Communication. System shall automatically contact operator workstation or server on receipt of critical alarms.



- H. Demand Limiting.
  - 1. System shall monitor building power consumption from building power meter pulse generator signals or from building feeder line watt transducer or current transformer.
  - 2. When power consumption exceeds adjustable levels, system shall automatically adjust setpoints, de-energize low-priority equipment, and take other programmatic actions to reduce demand as specified in Appendix A (Sequences of Operation). When demand drops below adjustable levels, system shall restore loads as specified.
- I. Maintenance Management. System shall generate maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits. Configure and enable maintenance alarms as specified in Section 25 20 11 Appendix A (Sequences of Operation). These maintenance alarms shall be able to be passed along to the asset/maintenance management system via open system BACnet integration. All maintenance alarm extensions, as shown in the point schedule, shall be setup with the correct parameters as part of this project.
- J. Sequencing. Application software shall sequence boilers, and pumps as specified in Appendix A (Sequences of Operation).
- K. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs.
- L. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.
- M. Energy Calculations.
  - 1. System shall accumulate and convert instantaneous power (kW) or flow rates (L/s [gpm]) to energy usage data.
  - 2. System shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.
- N. Anti-Short Cycling. Binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.
- O. On and Off Control with Differential. System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.
- P. Runtime Totalization. System shall provide an algorithm that can totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as specified in Appendix A (Sequence of Operations).

## **2.5 Controllers**

- A. General. Provide Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), Smart Actuators (SA), and Smart Sensors (SS) as required to achieve performance specified in Section 25 20 11 Article 1.9 (System Performance). Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of BACnet Smart Actuators and Smart Sensors. Controllers are to have a minimum of 25% spare capacity for all types of inputs and outputs listed in section 2.6 below.
- B. BACnet.
  - 1. Building Controllers (BCs). Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.
  - 2. Advanced Application Controllers (AACs). Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.

3. Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.
  4. Smart Actuators (SAs). Each SA shall conform to BACnet Smart Actuator (B-SA) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-SA in the BACnet Testing Laboratories (BTL) Product Listing.
  5. Smart Sensors (SSs). Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.
  6. BACnet Communication.
    - a. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
    - b. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
    - c. Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
    - d. Each ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
    - e. Each SA shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
    - f. Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using ARCNET or MS/TP Data Link/Physical layer protocol.
- C. Communication.
1. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
  2. Signal Management. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
  3. Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
  4. Stand-Alone Operation. Each piece of equipment specified in Section 25 20 11 Appendix A shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.
- D. Environment. Controller hardware shall be suitable for anticipated ambient conditions.
1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
  2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).
- E. Keypad. Provide a local keypad and display for each BC and AAC. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not normally provide a keypad and display for each BC and AAC, provide the software and any interface cabling needed to use a laptop computer as a Portable Operator's Terminal for the system. Controls contractor is to work with the Owner to determine which points shall be accessible via the local keypad. These points shall be setup by the controls contractor.
- F. Real-Time Clock. Controllers that perform scheduling shall have a real-time clock.

- G. Serviceability.
  - 1. Controllers shall have diagnostic LEDs for power, communication, and processor.
  - 2. Wires shall be connected to a field-removable modular terminal strip or to a termination card connected by a ribbon cable.
  - 3. Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.
- H. Memory.
  - 1. Controller memory shall support operating system, database, and programming requirements.
  - 2. Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.
  - 3. Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.
- I. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
- J. Transformer. ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption. For all heat pumps, the control power for the BAS controller to be provided by the contractor. The control transformer supplied by the heat pump manufacturer is not to be used to power the BAS controller.

## **2.6 Input and Output Interface**

- A. General. Hard-wire input and output points to BCs, AACs, ASCs, or SAs.
- B. Protection. Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with up to 24 V for any duration shall cause no controller damage.
- C. Binary Inputs. Binary inputs shall monitor the on and off signal from a remote device. Binary inputs shall provide a wetting current of at least 12 mA and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.
- D. Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall accumulate up to 10 pulses per second.
- E. Analog Inputs. Analog inputs shall monitor low-voltage (0-10 Vdc), current (4-20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
- F. Binary Outputs. Binary outputs shall send an on-or-off signal for on and off control. Building Controller binary outputs shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.
- G. Analog Outputs. Analog outputs shall send a modulating 0-10 Vdc or 4-20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.
- H. Tri-State Outputs. Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.
- I. Universal Inputs and Outputs. Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.

## 2.7 Power Supplies And Line Filtering

- A. Power Supplies. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
  - 1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.
    - a. Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
    - b. Line voltage units shall be UL recognized and CSA listed.
- B. Power Line Filtering.
  - 1. Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:
    - a. Dielectric strength of 1000 V minimum
    - b. Response time of 10 nanoseconds or less
    - c. Transverse mode noise attenuation of 65 dB or greater
    - d. Common mode noise attenuation of 150 dB or greater at 40-100 Hz

## 2.8 Auxiliary Control Devices

- A. Motorized Control Dampers.
  - 1. Type. Control dampers shall have linear flow characteristics and shall be parallel- or opposed-blade type as specified below or as scheduled on drawings.
    - a. Outdoor and return air mixing dampers and face-and-bypass dampers shall be parallel-blade and shall direct airstreams toward each other.
    - b. Other modulating dampers shall be opposed-blade.
    - c. Two-position shutoff dampers shall be parallel- or opposed-blade with blade and side seals.
  - 2. Frame. Damper frames shall be 2.38 mm (13 gauge) galvanized steel channel or 3.175 mm (1/8 in.) extruded aluminum with reinforced corner bracing.
  - 3. Blades. Damper blades shall not exceed 20 cm (8 in.) in width or 125 cm (48 in.) in length. Blades shall be suitable for medium velocity (10 m/s [2000 fpm]) performance. Blades shall be not less than 1.5875 mm (16 gauge).
  - 4. Shaft Bearings. Damper shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze, or better.
  - 5. Seals. Blade edges and frame top and bottom shall have replaceable seals of butyl rubber or neoprene. Side seals shall be spring-loaded stainless steel. Blade seals shall leak no more than 50 L/s·m<sup>2</sup> (10 cfm per ft<sup>2</sup>) at 1000 Pa (4 in. w.g.) differential pressure. Blades shall be airfoil type suitable for wide-open face velocity of 7.5 m/s (1500 fpm).
  - 6. Sections. Damper sections shall not exceed 125 cm - 150 cm (48 in. - 60 in.). Each section shall have at least one damper actuator.
  - 7. Linkages. Dampers shall have exposed linkages.
- B. Electric Damper and Valve Actuators.
  - 1. Stall Protection. Mechanical or electronic stall protection shall prevent actuator damage throughout the actuator's rotation.
  - 2. Spring-return Mechanism. Actuators used for power-failure and safety applications shall have an internal mechanical spring-return mechanism or an uninterruptible power supply (UPS).

3. Signal and Range. Proportional actuators shall accept a 0-10 Vdc or a 0-20 mA control signal and shall have a 2-10 Vdc or 4-20 mA operating range. (Floating motor actuators may be substituted for proportional actuators in terminal unit applications as described in paragraph 2.6H.)
  4. Wiring. 24 Vac and 24 Vdc actuators shall operate on Class 2 wiring.
  5. Manual Positioning. Operators shall be able to manually position each actuator when the actuator is not powered. Non-spring-return actuators shall have an external manual gear release. Spring-return actuators with more than 7 N·m (60 in.-lb) torque capacity shall have a manual crank.
- C. Control Valves.
1. General. Select body and trim materials in accordance with manufacturer's recommendations for design conditions and service shown.
  2. **Provide 0-10V fully modulating valves.**
  3. Type. Provide two- or three-way control valves for two-position or modulating service as shown.
  4. Water Valves.
    - a. Valves providing two-position service shall be quick opening. Two-way valves shall have replaceable disc or ball.
    - b. Close-off (Differential) Pressure Rating. Valve actuator and trim shall provide the following minimum close-off pressure ratings.
      - i. Two-way: 150% of total system (pump) head.
      - ii. Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
    - c. Ports. Valves providing modulating service shall have equal percentage ports.
    - d. Sizing.
      - i. Two-position service: line size.
      - ii. Two-way modulating service: select pressure drop equal to the greatest of twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 35 kPa (5 psi).
      - iii. Three-way modulating service: select pressure drop equal to the smaller of twice the pressure drop through the coil exchanger (load) or 35 kPa (5 psi).
    - e. Fail Position. Water valves shall fail normally open or closed as follows unless otherwise specified.
      - i. Water zone valves: normally open.
      - ii. Heating coils in air handlers: normally open.
      - iii. Other applications: as scheduled or as required by sequences of operation.
- D. Binary Temperature Devices.
1. Low-Voltage Space Thermostats. Low-voltage space thermostats shall be 24 V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.
  2. Line-Voltage Space Thermostats. Line-voltage space thermostats shall be bimetal-actuated, open-contact type or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listing for electrical rating, concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.
  3. Low-Limit Thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type. Element shall be at least 6 m (20 ft) long. Element shall sense temperature in each 30 cm (1 ft) section and shall respond to lowest sensed temperature. Low-limit thermostat shall be manual reset only.
- E. Temperature Sensors.
1. Type. Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor.

2. Duct Sensors. Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 1.5 m (5 ft) in length per 1 m<sup>2</sup>(10 ft<sup>2</sup>) of duct cross-section.
  3. Immersion Sensors. Provide immersion sensors with a separable stainless steel well. Well pressure rating shall be consistent with system pressure it will be immersed in. Well shall withstand pipe design flow velocities.
  4. Space Sensors. Space sensors shall have setpoint adjustment, override switch, display, and communication port as shown.
  5. Differential Sensors. Provide matched sensors for differential temperature measurement.
- F. Humidity Sensors.
1. Duct and room sensors shall have a sensing range of 20%-80%.
  2. Duct sensors shall have a sampling chamber.
  3. Outdoor air humidity sensors shall have a sensing range of 20%-95% RH and shall be suitable for ambient conditions of 40°C-75°C (40°F-170°F).
  4. Humidity sensors shall not drift more than 1% of full scale annually.
- G. Flow Switches. Flow-proving switches shall be paddle (water service only) or differential pressure type (air or water service) as shown. Switches shall be UL listed, SPDT snap-acting, and pilot duty rated (125 VA minimum).
1. Paddle switches shall have adjustable sensitivity and NEMA 1 enclosure unless otherwise specified.
  2. Differential pressure switches shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.
- H. Relays.
1. Control Relays. Control relays shall be plug-in type, UL listed, and shall have dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
  2. Time Delay Relays. Time delay relays shall be solid-state plug-in type, UL listed, and shall have adjustable time delay. Delay shall be adjustable  $\pm 100\%$  from setpoint shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.
  3. **Provide hand/off/auto DVRs.**
- I. Override Timers.
1. Unless implemented in control software, override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration required by application. Provide 0-6 hour calibrated dial unless otherwise specified. Flush mount timer on local control panel face or where shown.
- J. Current Transmitters.
1. AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4-20 mA two-wire output. Full-scale unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment. Unit accuracy shall be  $\pm 1\%$  full-scale at 500 ohm maximum burden.
  2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.
  3. Unit shall be split-core type for clamp-on installation on existing wiring.
- K. Current Transformers.
1. AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material.
  2. Transformers shall be available in various current ratios and shall be selected for  $\pm 1\%$  accuracy at 5 A full-scale output.
  3. Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.
- L. Voltage Transmitters.
1. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4-20 mA output with zero and span adjustment.

2. Adjustable full-scale unit ranges shall be 100-130 Vac, 200-250 Vac, 250-330 Vac, and 400-600 Vac. Unit accuracy shall be  $\pm 1\%$  full-scale at 500 ohm maximum burden.
  3. Transmitters shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized at 600 Vac rating.
- M. Voltage Transformers.
1. AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.
  2. Transformers shall be suitable for ambient temperatures of 4°C-55°C (40°F-130°F) and shall provide  $\pm 0.5\%$  accuracy at 24 Vac and 5 VA load.
  3. Windings (except for terminals) shall be completely enclosed with metal or plastic.
- N. Power Monitors.
1. Power monitors shall be three-phase type and shall have three-phase disconnect and shorting switch assembly, UL listed voltage transformers, and UL listed split-core current transformers.
  2. Power monitors shall operate with 5 A current inputs and maximum error of  $\pm 2\%$  at 1.0 power factor or  $\pm 2.5\%$  at 0.5 power factor.
  3. Schneider Electric PowerLogic PM5560 Power & Energy Meters are to be supplied.
- O. Current Switches.
1. Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.
- P. Pressure Transducers.
1. Transducers shall have linear output signal and field-adjustable zero and span.
  2. Continuous operating conditions of positive or negative pressure 50% greater than calibrated span shall not damage transducer sensing elements.
  3. Water pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Transducer shall have 4-20 mA output, suitable mounting provisions, and block and bleed valves.
  4. Water differential pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Over-range limit (differential pressure) and maximum static pressure shall be 2000 kPa (300 psi.) Transducer shall have 4-20 mA output, suitable mounting provisions, and 5-valve manifold.
- Q. Differential Pressure Switches. Differential pressure switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.
- R. Pressure-Electric (PE) Switches. PE switches shall be UL listed, pilot duty rated (125 VA minimum) or motor control rated, metal or neoprene diaphragm actuated, operating pressure rated for 0-175 kPa (0-25 psig), with calibrated scale minimum setpoint range of 14-125 kPa (2-18 psig).
1. Provide one- or two-stage switch action (SPDT, DPST, or DPDT) as required by application.
  2. Switches shall be open type (panel-mounted). Exception: Switches shall be enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified.
  3. Each pneumatic signal line to PE switches shall have permanent indicating gauge.
- S. Local Control Panels.
1. Indoor control panels shall be fully enclosed NEMA 1 construction with hinged door key-lock latch and removable sub-panels. A common key shall open each control panel and sub-panel.
  2. Prewire internal and face-mounted device connections with color-coded stranded conductors tie-wrapped or neatly installed in plastic troughs. Field connection terminals shall be UL listed for 600 V service, individually identified per control and interlock drawings, with adequate clearance for field wiring.
  3. Each local panel shall have a control power source power switch (on-off) with overcurrent protection.
- T. Water Consumption Meters.
1. Sensus Omni Turbo T2 meters are to be used. Meters are to be properly sized for the amount of consumption expected. These meters are supplied and installed by the mechanical contractor, and are interfaced to by the BAS contractor.

U. Gas Consumption Meters.

1. An add-on pulse meter output module, which is to be installed on the building's gas consumption meter by Union Gas, are to be used. Meters are to be properly sized for the amount of consumption expected. These meters are supplied and installed by the mechanical contractor, and are interfaced to by the BAS contractor.

V. Airflow measuring stations required to accomplish the specified control sequence shall be furnished under this section but installed under the sheet metal section. Airflow measuring stations shall be of heavy gauge metal construction, and shall be furnished with an air straightening section with an open face area of not less than 97%.

W. Each airflow measuring station shall measure airflow by means of a network of static and total pressure sensors factory positioned and connected in parallel to produce an averaged velocity pressure. The measured velocity pressure converted to airflow (CFM) shall have an accuracy within 2% of the full scale throughout the velocity range from 700 to 4,000 fpm when measured under ideal laboratory conditions. The location of stations shall meet manufacturer's guidelines.

X. The maximum resistance to airflow shall not exceed 0.6 times the velocity head. The unit shall be suitable to withstand temperatures up to 121°C (250°F).

## **2.9 Wiring And Raceways**

A. General. Provide copper wiring, plenum cable, and raceways as specified in applicable sections of Division 26 00 00.

B. Insulated wire shall use copper conductors and shall be UL listed for 90°C (200°F) minimum service.



## **PART 3: EXECUTION**

### **Part 3: Execution**

#### **Section Includes:**

- 3.1 Examination**
- 3.2 Protection**
- 3.3 Coordination**
- 3.4 General Workmanship**
- 3.5 Field Quality Control**
- 3.6 Wiring**
- 3.7 Communication Wiring**
- 3.8 Installation of Sensors**
- 3.9 Flow Switch Installation**
- 3.10 Actuators**
- 3.11 Warning Labels**
- 3.12 Identification of Hardware and Wiring**
- 3.13 Programming**
- 3.14 Control System Checkout and Testing**
- 3.15 Control System Demonstration and Acceptance**
- 3.16 Cleaning**
- 3.17 Training**
- 3.18 Sequence of Operation**
- 3.19 Points List**

### **3.1 Examination**

- A. Thoroughly examine project plans for control device and equipment locations. Report discrepancies, conflicts, or omissions to Architect or Engineer for resolution before starting rough-in work.
- B. Inspect site to verify that equipment can be installed as shown. Report discrepancies, conflicts, or omissions to Engineer for resolution before starting rough-in work.
- C. Examine drawings and specifications for work of others. Report inadequate headroom or space conditions or other discrepancies to Engineer and obtain written instructions for changes necessary to accommodate Section 25 20 11 work with work of others. Controls Contractor shall perform at his expense necessary changes in specified work caused by failure or neglect to report discrepancies.

### **3.2 Protection**

- A. Controls Contractor shall protect against and be liable for damage to work and to material caused by Contractor's work or employees.
- B. Controls Contractor shall be responsible for work and equipment until inspected, tested, and accepted. Protect material not immediately installed. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

### **3.3 Coordination**

- A. Site.
  - 1. Assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will interfere with work of other trades. If installation without coordination causes interference with work of other trades, Contractor shall correct conditions without extra charge.
  - 2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.
- B. Submittals. See Section 25 20 11 Article 1.10 (Submittals).
- C. Test and Balance.
  - 1. Provide Test and Balance Contractor a single set of necessary tools to interface to control system for testing and balancing.
  - 2. Train Test and Balance Contractor to use control system interface tools.
  - 3. Provide a qualified technician to assist with testing and balancing the first 20 terminal units.
  - 4. Test and Balance Contractor shall return tools undamaged and in working condition at completion of testing and balancing.
- D. Life Safety.
  - 1. Duct smoke detectors required for air handler shutdown are provided under Division 16. Interlock smoke detectors to air handlers for shutdown as specified in Section 25 20 11 Appendix A (Sequences of Operation).
  - 2. Smoke dampers and actuators required for duct smoke isolation are provided under Division 15. Interlock smoke dampers to air handlers as specified in Section 25 20 11 Appendix A (Sequences of Operation).
  - 3. Fire and smoke dampers and actuators required for fire-rated walls are provided under Division 15. Fire and smoke damper control is provided under Division 16.
- E. Coordination with Other Controls. Integrate with and coordinate controls and control devices furnished or installed by others as follows.
  - 1. Communication media and equipment shall be provided as specified in Section 25 20 11 Article 2.2 (Communication).
  - 2. Each supplier of a controls product shall configure, program, start up, and test that product to meet the sequences of operation described in Section 25 20 11 Appendix A regardless of where within the contract documents those products are described.

3. Coordinate and resolve incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of this specification.
4. Controls Contractor shall be responsible for integration of control products provided by multiple suppliers regardless of where integration is described within the contract documents.

### **3.4 General Workmanship**

- A. Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.
- B. Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.
- C. Install equipment in readily accessible locations as defined by National Electrical Code (NEC) Chapter 1 Article 100 Part A.
- D. Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.
- E. Equipment, installation, and wiring shall comply with industry specifications and standards and local codes for performance, reliability, and compatibility.

### **3.5 Field Quality Control**

- A. Work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances as identified in Section 25 20 11 Article 1.8 (Codes and Standards).
- B. Continually monitor field installation for code compliance and workmanship quality.
- C. Contractor shall arrange for work inspection by local or state authorities having jurisdiction over the work.

### **3.6 Wiring**

- A. Rules and Regulations: The entire installation shall conform to Division 16 and shall comply with the Canadian Electrical Code and all local and Provincial codes. The contractor shall obtain an ESA certificate for his work.
- B. Refer to equipment wiring schedule or electrical drawings for wiring responsibilities.
- C. Arrange for all the necessary inspections and approvals of built-up and modified control systems and relay panels by governing authorities. All electrical equipment , material , and its installation shall conform to the current requirements of the following authorities:
  - .1 C.S.A
  - .2 Ontario Hydro Safety Authority
  - .3 O.B.C. Building Codes / Fire Codes.
- D. All wiring shall conform to governing codes and shall be inspected by request of the contractor for approval. The contractor shall obtain and purchase all necessary permits as required.
- E. Conduits: All wiring in finished areas shall be concealed. All exposed wiring, whether for power, sensors, actuators, or data communications, shall be in metallic conduit. This includes all wiring runs in and around rooftop HVAC units. All conduits shall have a minimum inside diameter of 13mm.
  - .1 All conduits shall be installed out of the way in traffic areas, and parallel to the lines of the building. Flexible conduit may be used only in areas of vibration or expansion joints. All conduits shall be supported at least every 4 feet.
  - .2 Supports shall be located at each connector end of each conduit. High and low voltage wire shall not be run in the same conduit.
  - .3 Only wires of similar purpose shall be run in the same conduit; i.e. sensor or control, power, and communication wire shall be in separate conduit.
- F. Pull Boxes and Junction Boxes: Pull boxes shall be located at a minimum spacing of 30m. The contractor is responsible for getting approvals from the Owner for locating pull boxes. Pull boxes shall comply with the Canadian Electrical Code. All boxes shall be clearly marked as part of the automated control system.

- G. Supply, install and terminate all necessary control wiring and interlock wiring required for equipment specified elsewhere.
- H. Control and interlock wiring and installation shall comply with national and local electrical codes, Division 16, and manufacturer's recommendations. Where the requirements of Section 25 20 11 differ from Division 16, Section 25 20 11 shall take precedence.
- I. NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway as specified by NEC and Division 16.
- J. Low-voltage wiring shall meet NEC Class 2 requirements. Subfuse low-voltage power circuits as required to meet Class 2 current limit.
- K. NEC Class 2 (current-limited) wires not in raceway but in concealed and accessible locations such as return air plenums shall be UL listed for the intended application.
- L. Install wiring in raceway where subject to mechanical damage and at levels below 3 m (10ft) in mechanical, electrical, or service rooms.
- M. Install Class 1 and Class 2 wiring in separate raceways. Boxes and panels containing high-voltage wiring and equipment shall not be used for low-voltage wiring except for the purpose of interfacing the two through relays and transformers.
- N. Do not install wiring in raceway containing tubing.
- O. Run exposed Class 2 wiring parallel to a surface or perpendicular to it and tie neatly at 3 m (10 ft) intervals.
- P. Use structural members to support or anchor plenum cables without raceway. Do not use ductwork, electrical raceways, piping, or ceiling suspension systems to support or anchor cables.
- Q. Secure raceways with raceway clamps fastened to structure and spaced according to code requirements. Raceways and pull boxes shall not be hung on or attached to ductwork, electrical raceways, piping, or ceiling suspension systems.
- R. Size raceway and select wire size and type in accordance with manufacturer's recommendations and NEC requirements.
- S. Include one pull string in each raceway 2.5 cm (1 in.) or larger.
- T. Use color-coded conductors throughout.
- U. Locate control and status relays in designated enclosures only. Do not install control and status relays in packaged equipment control panel enclosures containing Class 1 starters.
- V. Conceal raceways except within mechanical, electrical, or service rooms. Maintain minimum clearance of 15 cm (6 in.) between raceway and high-temperature equipment such as steam pipes or flues.
- W. Adhere to requirements in the Electrical Specification where raceway crosses building expansion joints.
- X. Install insulated bushings on raceway ends and enclosure openings. Seal top ends of vertical raceways.
- Y. Terminate control and interlock wiring related to the work of this section. Maintain at the job site updated (as-built) wiring diagrams that identify terminations.
- Z. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Do not use flexible metal raceway less than ½ in. electrical trade size. Use liquid-tight flexible metal raceways in areas exposed to moisture including chiller and boiler rooms.
- AA. Install raceway rigidly, support adequately, ream at both ends, and leave clean and free of obstructions. Join raceway sections with couplings and according to code. Make terminations in boxes with fittings. Make terminations not in boxes with bushings.
- BB. All wiring line and low voltage shall be installed in EMT conduit unless specifically specified otherwise.
- CC. 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 strap-on sensors.
- DD. Power for control system shall not be obtained by tapping into miscellaneous circuits that could be inadvertently be switched off.
- EE. Mount transformers and other peripheral equipment in panels located in serviceable areas. Provide line side breakers/fuses for all transformers.

- FF. 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.
- GG. All BAS control panels shall be provided with UPS in the power supply except for Application Specific Controllers (ASC).
- HH. All BAS control wiring shall be yellow jacket for identification purpose.
- II. The breaker or power isolation location shall be clearly marked on the inside door of each BAS panel enclosure.
- JJ. A 120 VAC duplex receptacle for laptop power shall be provided if the cabinet is located further than 1500 mm (5') laterally from the nearest outlet.
- KK. It is the responsibility of this contractor to provide dedicated 120 V, power from the spare breaker for the automation system from the nearest electrical panel. Provide typewritten information on panel directory.

### **3.7 Communication Wiring**

- A. Communication wiring shall be low-voltage Class 2 wiring and shall comply with Article 3.7 (Wiring).
- B. Install communication wiring in separate raceways and enclosures from other Class 2 wiring.
- C. During installation do not exceed maximum cable pulling, tension, or bend radius specified by the cable manufacturer.
- D. Verify entire network's integrity following cable installation using appropriate tests for each cable.
- E. Install lightning arrestor according to manufacturer's recommendations between cable and ground where a cable enters or exits a building.
- F. Each run of communication wiring shall be a continuous length without splices when that length is commercially available. Runs longer than commercially available lengths shall have as few splices as possible using commercially available lengths.
- G. Label communication wiring to indicate origination and destination.
- H. Ground coaxial cable according to NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."
- I. BACnet MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:
  - 1. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot.)
  - 2. The maximum length of an MS/TP segment is 1200 meters (4000 ft) with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
  - 3. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
  - 4. An MS/TP EIA-485 network shall have no T connections.
- J. Contractor to extend the BAS communication trunk to the area of the future addition.

### **3.8 Installation of Sensors**

- A. Install sensors according to manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for operating environment.
- C. Install room temperature sensors on concealed junction boxes properly supported by wall framing.
- D. All exposed sensors installed in the gymnasium area are to be installed complete with steel protective cages to prevent damage.
- E. Air seal wires attached to sensors in their raceways or in the wall to prevent sensor readings from being affected by air transmitted from other areas.
- F. Use averaging sensors in mixing plenums and hot and cold decks. Install averaging sensors in a serpentine manner vertically across duct. Support each bend with a capillary clip.

- G. Install mixing plenum low-limit sensors in a serpentine manner horizontally across duct. Support each bend with a capillary clip. Provide 3 m (1 ft) of sensing element for each 1 m<sup>2</sup> (1 ft<sup>2</sup>) of coil area.
- H. Install pipe-mounted temperature sensors in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.
- I. Install outdoor air temperature sensors on north wall at designated location with sun shield.
- J. Differential Air Static Pressure.
  - 1. Supply Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.
  - 2. Return Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.
  - 3. Building Static Pressure. Pipe pressure sensor's low-pressure port to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe high-pressure port to a location behind a thermostat cover.
  - 4. Piping to pressure transducer pressure ports shall contain a capped test port adjacent to transducer.
  - 5. Pressure transducers, except those controlling VAV boxes, shall be located in control panels, not on monitored equipment or on ductwork. Mount transducers in a vibration-free location accessible for service without use of ladders or special equipment.
  - 6. Mount gauge tees adjacent to air and water differential pressure taps. Install shut-off valves before tee for water gauges.
- K. Smoke detectors, freezestats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.

### **3.9 Flow Switch Installation**

- A. Use correct paddle for pipe diameter.
- B. Adjust flow switch according to manufacturer's instructions.

### **3.10 Actuators**

- A. General. Mount actuators and adapters according to manufacturer's recommendations.
- B. Electric and Electronic Damper Actuators. Mount actuators directly on damper shaft or jackshaft unless shown as a linkage installation. Link actuators according to manufacturer's recommendations.
  - 1. For low-leakage dampers with seals, mount actuator with a minimum 5° travel available for damper seal tightening.
  - 2. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, then tighten linkage.
  - 3. Check operation of damper-actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
  - 4. Provide necessary mounting hardware and linkages for actuator installation.
- C. Valve Actuators. Connect actuators to valves with adapters approved by actuator manufacturer.

### **3.11 Warning Labels**

- A. Affix permanent warning labels to equipment that can be automatically started by the control system.
  - 1. Labels shall use white lettering (12-point type or larger) on a red background.
  - 2. Warning labels shall read as follows.

#### **CAUTION**

**This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.**

- B. Affix permanent warning labels to motor starters and control panels that are connected to multiple power sources utilizing separate disconnects.
  - 1. Labels shall use white lettering (12-point type or larger) on a red background.
  - 2. Warning labels shall read as follows.

**CAUTION**

**This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.**

### **3.12 Identification of Hardware and Wiring**

- A. Label wiring and cabling, including that within factory-fabricated panels, with control system address or termination number at each end within 5 cm (2 in.) of termination.
- B. Label pneumatic tubing at each end within 5 cm (2 in.) of termination with a descriptive identifier.
- C. Permanently label or code each point of field terminal strips to show instrument or item served.
- D. Label control panels with minimum 1 cm (½ in.) letters on laminated plastic nameplates.
- E. Label each control component with a permanent label. Label plug-in components such that label remains stationary during component replacement.
- F. Label room sensors related to terminal boxes or valves with nameplates.
- G. Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.
- H. Label identifiers shall match record documents.

### **3.13 Programming**

- A. Point Naming. Name points as shown on the equipment points list provided with each sequence of operation. See Section 25 20 11 Appendix A (Sequences of Operation) and point schedule. If character limitations or space restrictions make it advisable to shorten the name, the abbreviations given in Appendix C may be used. Where multiple points with the same name reside in the same controller, each point name may be customized with its associated Program Object number. For example, "Zone Temp 1" for Zone 1, "Zone Temp 2" for Zone 2.
- B. Software Programming. Programming shall provide actions for each possible situation. Graphic- or parameter-based programs shall be documented. Text-based programs shall be modular, structured, and commented to clearly describe each section of the program.
  - 1. Application Programming. Provide application programming that adheres to sequences of operation specified in Section 25 20 11 Appendix A. Program documentation or comment statements shall reflect language used in sequences of operation.
  - 2. System Programming. Provide system programming necessary for system operation.
- C. Operator Interface.
  - 1. Standard Graphics. Provide graphics as specified in Section 25 20 11 Article 2.3 Paragraph E.2 (System Graphics). Show on each equipment graphic input and output points and relevant calculated points such as indicated on the applicable Points List in Section 25 20 11 Appendix A. Point information on graphics shall dynamically update.
  - 2. Install, initialize, start up, and troubleshoot operator interface software and functions (including operating system software, operator interface database, and third-party software installation and integration required for successful operator interface operation) as described in Section 25 20 11.
- D. Input and Output Sensors – Type Of Measurement Units.
  - 1. All input and output devices and sensors used on the project shall be configured and displayed on the BAS in Metric units.

### **3.14 Control System Checkout and Testing**

- A. Startup Testing. Complete startup testing to verify operational control system before notifying Owner of system demonstration. Provide Owner with schedule for startup testing. Owner may have representative present during any or all startup testing.
1. Calibrate and prepare for service each instrument, control, and accessory equipment furnished under Section 25 20 11.
  2. Verify that control wiring is properly connected and free of shorts and ground faults. Verify that terminations are tight.
  3. Enable control systems and verify each input device's calibration. Calibrate each device according to manufacturer's recommendations.
  4. Verify that binary output devices such as relays, solenoid valves, two-position actuators and control valves, and magnetic starters, operate properly and that normal positions are correct.
  5. Verify that analog output devices such as I/Ps and actuators are functional, that start and span are correct, and that direction and normal positions are correct. Check control valves and automatic dampers to ensure proper action and closure. Make necessary adjustments to valve stem and damper blade travel.
  6. Prepare a log documenting startup testing of each input and output device, with technician's initials certifying each device has been tested and calibrated.
  7. Verify that system operates according to sequences of operation. Simulate and observe each operational mode by overriding and varying inputs and schedules. Tune PID loops and each control routine that requires tuning.
  8. Alarms and Interlocks.
    - a. Check each alarm with an appropriate signal at a value that will trip the alarm.
    - b. Trip interlocks using field contacts to check logic and to ensure that actuators fail in the proper direction.
    - c. Test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.

### **3.15 Control System Demonstration and Acceptance**

- A. Demonstration. Prior to acceptance, perform the following performance tests to demonstrate system operation and compliance with specification after and in addition to tests specified in Article 3.15 (Control System Checkout and Testing). Provide Engineer with log documenting completion of startup tests.
1. Engineer will be present to observe and review system demonstration. Notify Engineer at least 10 days before system demonstration begins.
  2. Demonstration shall follow process submitted and approved under Section 25 20 11 Article 1.10 (Submittals). Complete approved checklists and forms for each system as part of system demonstration.
  3. Demonstrate actual field operation of each sequence of operation as specified in Section 25 20 11 Appendix A. Provide at least two persons equipped with two-way communication. Demonstrate calibration and response of any input and output points requested by Engineer. Provide and operate test equipment required to prove proper system operation.
  4. Demonstrate compliance with Section 25 20 11 Part 1 (System Performance).
  5. Demonstrate compliance with sequences of operation through each operational mode.
  6. Demonstrate complete operation of operator interface.



7. Demonstrate each of the following.
    - a. DDC loop response. Supply graphical trend data output showing each DDC loop's response to a setpoint change representing an actuator position change of at least 25% of full range. Trend sampling rate shall be from 10 seconds to 3 minutes, depending on loop speed. Each sample's trend data shall show setpoint, actuator position, and controlled variable values. Engineer will require further tuning of each loop that displays unreasonably under- or over-damped control.
    - b. Demand limiting. Supply trend data output showing demand-limiting algorithm action. Trend data shall document action sampled each minute over at least a 30-minute period and shall show building kW, demand-limiting setpoint, and status of setpoints and other affected equipment parameters.
    - c. Building fire alarm system interface.
    - d. Trend logs for each system. Trend data shall indicate setpoints, operating points, valve positions, and other data as specified in the points list provided with each sequence of operation in Section 25 20 11 Appendix A. Each log shall cover three 48-hour periods and shall have a sample frequency not less than 10 minutes or as specified on its points list. Logs shall be accessible through system's operator interface and shall be retrievable for use in other software programs as specified in Section 25 20 11 Article 2.3 Paragraph E.11 (Trend Configuration).
  8. Tests that fail to demonstrate proper system operation shall be repeated after Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.
- B. Acceptance.
1. After tests described in this specification are performed to the satisfaction of both Engineer and Owner, Engineer will accept control system as meeting completion requirements. Engineer may exempt tests from completion requirements that cannot be performed due to circumstances beyond Contractor's control. Engineer will provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.
  2. System shall not be accepted until completed demonstration forms and checklists are submitted and approved as required in Section 25 20 11 Article 1.10 (Submittals).

### **3.16 Cleaning**

- A. Each day clean up debris resulting from work. Remove packaging material as soon as its contents have been removed. Collect waste and place in designated location.
- B. On completion of work in each area, clean work debris and equipment. Keep areas free from dust, dirt, and debris.
- C. On completion of work, check equipment furnished under this section for paint damage. Repair damaged factory-finished paint to match adjacent areas. Replace deformed cabinets and enclosures with new material and repaint to match adjacent areas.

### **3.17 Training**

- A. Provide training for a designated staff of Owner's representatives. Training shall be provided via a combination of self-paced training, web-based or computer-based training, hands-on onsite training and classroom training. The training shall be 24 hours in duration, and split into 3 different sessions (see 3.18.C).
- B. Training shall enable students to accomplish the following objectives.
  1. Proficiently operate system
  2. Understand control system architecture and configuration
  3. Understand DDC system components
  4. Understand system operation, including DDC system control and optimizing routines (algorithms)

5. Operate workstation and peripherals
  6. Log on and off system
  7. Access graphics, point reports, and logs
  8. Adjust and change system setpoints, time schedules, and holiday schedules
  9. Recognize common HVAC system malfunctions by observing system graphics, trend graphs, and other system tools
  10. Understand system drawings and Operation and Maintenance manual
  11. Understand job layout and location of control components
  12. Access data from DDC controllers
  13. Operate portable operator's terminals
  14. Create and change system graphics
  15. Create, delete, and modify alarms, including configuring alarm reactions
  16. Create, delete, and modify point trend logs (graphs) and multi-point trend graphs
  17. Configure and run reports
  18. Add, remove, and modify system's physical points
  19. Create, modify, and delete application programming
  20. Add operator interface stations
  21. Add a new controller to system
  22. Download firmware and advanced applications programming to a controller
  23. Configure and calibrate I/O points
  24. Maintain software and prepare backups
  25. Interface with job-specific, third-party operator software
  26. Add new users and understand password security procedures
- C. Divide presentation of objectives into three sessions (1-13, 14-23, and 24-26). Participants will attend one or more of sessions, depending on knowledge level required.
1. Day-to-day Operators (objectives 1-13)
  2. Advanced Operators (objectives 1-13 and 14-23)
  3. System Managers and Administrators (objectives 1-13 and 24-26)
- D. Provide course outline and materials according to Section 25 20 11 Article 1.10 (Submittals). Provide one copy of training material per student.
- E. Instructors shall be factory-trained and experienced in presenting this material.
- F. Perform classroom training using a network of working controllers representative of installed hardware.

## APPENDIX A: Sequences of Operation

### .1 Hot Water Boiler System

Existing two boiler xx pump system to be modified to suit additional boiler and two additional zone pumps.

The hot water boiler system shall be enabled to run whenever the boiler system manual enable point is enabled, the boiler system calendar enable point is enabled, and the outdoor air temperature is less than the OA-T enable setpoint (adjustable, initially set at 15 deg C). The system shall be disabled when the outdoor air temperature is greater than the OA-T enable setpoint, plus a differential of 2 deg C, or if the manual enable point or calendar enable point have been disabled. The system will also look at any temporary calendars and schedules (adjustable) to determine if the system should be enabled or not. When the system has been disabled, all pumps which are running at that time will continue to run for 10 minutes before turning off.

To prevent short cycling, each boiler shall run for and be off for minimum adjustable times (10 minutes, adjustable), unless shutdown on safeties or outside air conditions.

The calculated primary hot water supply temperature setpoint shall be determined based on the The hydronic heating system shall operate on two 3-point reset curves for determining the supply water temperature setpoint. The system shall toggle between the two curves based on the room temperature that is farthest from setpoint.

When the maximum deviation between the classroom temperature and it's corresponding zone setpoint is less than 3 - 4°F (adj.) the setpoint will use the "condensing" reset curve. (Include a 3 - 2°F deadband).

Modify the existing boiler staging to suit three boilers. The boilers are to be staged such that the boilers operate to provide high temperature water during high demand, and operates in condensing mode supplying lower water temperature during low demand. The system shall select the condensing schedule based on the space temperature demand.

During a high temperature demand, the boilers are to be enabled to achieve space temperature setpoint.

Reset the boiler supply water temperature for high heat demand inversely as a function of the outdoor air temperature as a 3 part curve:

Non-condensing Curve Supply Water Temperature	Outdoor Air Temperature
185°F (85°C)	5°F (-15°C)
158°F (70°C)	23°F (-5°C)
140°F (60°C)	41°F (5°C)

Reset the boiler supply water temperature for low heat demand inversely as a function of the outdoor air temperature as a 3 part curve:

Supply Water Temperature	Outdoor Air Temperature
131°F (55°C)	5°F (-15°C)
118°F (48°C)	23°F (-5°C)
104°F (40°C)	41°F (5°C)

Each of the three boilers shall run subject to its own internal safeties and controls. The lead boiler will be switched automatically based on equal runtime. On a call for heating, the lead boiler's circulating pump shall be enabled. Once the circulating pump status has been received by the BAS, that boiler's demand signal will be modulated to satisfy the calculated primary hot water supply temperature.

The demand signal for any boiler will be throttled back if the boiler's individual hot water supply temperature rises above its supply temperature high limit setpoint (adjustable, initially set at 88 deg C). If any boilers' general alarm point is in alarm, that boiler will be disabled, and the next boiler will be enabled.

If the lead boiler's demand signal reaches 100%, and the calculated setpoint has still not been satisfied, the second boiler's (based on next lowest runtime) circulating pump will be enabled. Once the second boiler's circulating pump status has been received by the BAS, the lead boiler's demand signal will be modulated back to minimum demand, and both boilers' demand signals will be modulated together to satisfy the calculated primary hot water supply temperature.

Once the second boiler's demand signal reaches 100%, and the calculated setpoint has still not been satisfied, the third boiler's circulating pump will be enabled. Once the third boiler's circulating pump status has been received by BAS, all three boilers' demand signals will be modulated back to minimum demand, and all three boilers demand signals will be modulated together to satisfy the calculated primary hot water supply temperature.

After a boiler has shutdown, its associated circulating pump shall remain on for a short amount of time (5 minutes, adjustable).

Manual switches shall be provided to select between "Local/BAS" control of the individual boilers to provide back-up in the event of a BAS failure.

When the boiler system is enabled, the perimeter heating loop pumps will be enabled. When the pump status is received by the BAS, the perimeter heating loop control scheme will be enabled. Modify the existing pump sequence to include new pumps.

Wire devices provided by the boiler manufacturer in accordance with the manufacturer's instructions.

Circulation pumps shall both operate on a lead/lag bases based on a run time counter when heating is enabled each of them shall be enabled automatically if the other fails. When there is no heating demand signal the pumps shall be OFF. When there is no heating demand signal the pumps shall be off and shall be enabled for 2 hours Pump Cycle per week. Pumps shall have a minimum off time of 5 minutes.

The VFDs for pump C-6 and C-7 will modulate to maintain the differential pressure at the differential pressure setpoint (adjustable, initially set at 70 kPa, the actual value is to be determined by the balancing contractor). The differential pressure sensor shall be installed 2/3 of the way out in each system ( one per floor to be approved by consultants). The differential pressure sensor is to be hardwired back to the local controller; sharing the sensor values over the BAS network is not allowed.

The boiler control shall be through hardwired points (0-10 VDC) signal for control of firing date and enable/disable). Boiler run status and boiler alarm points shall be hardwired points to the BAS system. In addition the boilers shall be interfaced to the BAS system through the BACnet module to monitor all other available points (boiler run time, flue temperature, heat exchanger temperature, service required, indicator, and all other diagnostic information).

## Safeties/Alarms

If the boiler system is enabled, and the primary hot water return temperature falls below the "no heat" security alarm output setpoint (45 deg C, adjustable), the "no heat" security alarm output shall be enabled, to notify the security system of the issue. The BAS will wait for 30 minutes upon the initial enabling of the system before sending out the "no heat" security alarm. In the Boiler Room, there is a local horn, light and silence button for the "no heat" alarm. If the "no heat" condition exists, the local horn and light outputs will be enabled. These two points will remain enabled until the silence button is engaged.

If either of the three boilers' statuses does not match its associated boiler enable command, an alarm will be sent to the BAS, and that boiler will be taken out of the lead/lag sequencing.

If either of the three boilers' general alarm point is in alarm, an alarm will be sent to the BAS, and that boiler will be taken out of the lead/lag sequencing.

If either of the three boilers' circulating pump statuses does not match its associated boiler circulating pump enable command, an alarm will be sent to the BAS, and that boiler will be taken out of the lead/lag sequencing.

If any of the perimeter heating loop pump status does not match its associated perimeter heating loop pump enable command, an alarm will be sent to the BAS.

The boiler makeup water meter will be monitored through the BAS, and the consumption will be totalized. An alarm will be generated by the BAS if an abnormally large consumption of water is occurring.

## **.2 HVAC General**

Provide Optimum **TEMPERATURE** Start Stop (OTSS) as specified, equipment shall start-up based on global outdoor temperature, space temperature, and system response to assure that temperature conditions are reached at scheduled occupancy time (occupancy schedules are defined under time programs), and operate only in cooling cycles. In all cases, the optimum start program shall operate fully stand-alone in the local equipment controller. OTSS shall include a Night Cycle program applying to [cooling cycle] with the outdoor air dampers closed. The space temperature shall be used to determine the "fan on" and "supply cooling" command to maintain 82 degrees (adj.) for the cooling cycle.

Provide optimum **VENTILATION** start stop as specified. Equipment shall open and close fresh air dampers or energy recovery ventilators based on a global time schedule command or local command from CO<sub>2</sub> detection and operate in free cooling, and mechanical cooling modes. In all cases, the optimum ventilation program shall operate fully stand alone in the local equipment controller.

Where an Economizer Cycle (EC) is specified, it shall automatically enable the economizer mode based upon a temperature comparison of outdoor air and return air of each AHU. This shall override the ventilation schedule.

On package HVAC units the integral unit economizer, the integral controls shall be maintained. The building automation system shall communicate thru the HVAC unit controls to only override this device closed. It is unacceptable to disconnect the actuator wiring and take control of the ventilation damper motor by the building automation system.

Schedule the morning warm up to start at a pre-determined time before the Optimal Temperature Start Stop (OTSS) times. Schedule units for a staggered start timing (i.e. 5-10 minutes apart). The optimum start stop program should display the calculated start time for that particular unit. Users shall have the ability to create new schedules for any particular point or group of points.

Provide two-speed control for units over 7½ tons (refer to schedule on drawings).

### **.3 VAV Unit Operation**

#### **.1 General**

- .1 The variable volume air handling units consists of a mixed air section with outdoor air, exhaust air and return air dampers, filter, gas fired burner, packaged cooling, ERV supply and return fans with variable frequency drives. The unit is DDC controlled using electric actuation. All units shall be provided with terminal strips and BACNet integration cards.
- .2 Sequences are to meet ASHRAE Standard 36, High Performance Sequences of Operation for HVAC Systems. The BAS Contractor is responsible for full integration of the sequences, along with any additional requirements listed below.
- .3 Time delays shall be provided to prevent unit short cycling.
- .4 All temperature settings, time delays, percentage values or other set points used in the following sequences are to be adjustable.
- .5 Fan status shall be reported.
- .6 Units shall have a staggered start delay programmed into them for start-up on power failure.

#### **.2 Safeties and Limits**

- .1 Freeze Protection: Provide programming to ASHRAE Guideline 36 standard. There are three levels of freeze protection to be programmed into the software:
  - .1 If supply air temperature drops below 4.4°C (40°F) for 5 minutes, enable heating plant, override outdoor air damper position/ERV operation to minimum, and modulate the heat to maintain a supply air temperature of at least 6°C (42°F). Disable this function once the supply air temperature rises above 7°C (45°F) for 5 minutes.
  - .2 If supply air temperature drops below 3.3°C (38°F) for 5 minutes, fully close both the economizer/outdoor air damper for 1 hour and set an alarm at the OWS. After 1 hour the unit shall resume minimum outdoor air ventilation and entre the previous stage of freeze protection.
  - .3 If supply air temperature drops below 3.3°C (38°F) for 15 minutes or below 1°C (34°F) for 5 minutes, shut down supply and return fans, close outdoor air damper, open both the chilled water valves and energize both pumping systems. Also ensure heating plant is enabled, and modulate the heating valve to maintain the higher of the supply air temperature or mixed air temperature at 27°C (80°F), and send an alarm to the OWS. The freeze protection shall remain in place until reset by a software switch at the OWS.
  - .4 Provide a hardwired freeze stat that must be manually reset as a final safety.

#### **.2 System Start/Stop**

- .1 The unit fan may run in any mode except for unoccupied mode.
- .2 The unit shall only run in setback mode if there is a perimeter zone without perimeter radiation, or after the perimeter radiation has failed to maintain set point for a minimum of 15 minutes.
- .3 Provide an override switch at the OWS to enable the unit for 3 hours.

#### **.3 Control Strategy**

- .1 Provide a summation of total airflow from the VAV boxes on the graphic for the unit.

- .2 Determination of AHU Mode of Operation
  - .1 AHU system modes are the same as the zone groups served by the system. When zone groups served by an air-handling system are in different modes, the following hierarchy applies:
    - .1 Occupied mode
    - .2 Cool down mode
    - .3 Setup mode
    - .4 Warm-up mode
    - .5 Setback mode
    - .6 Freeze Protection setback mode
    - .7 Unoccupied mode
- .3 Static Pressure Control
  - .1 Static Pressure Reset. Provide static pressure reset using Trim and Respond Set-Point Logic to ASHRAE Standard 36, High-Performance Sequences of Operation. All parameters shall be adjustable by the operator at the OWS.
  - .2 BAS shall modulate the VFD of the supply and return fans to maintain the static pressure set point.
  - .3 The speed AO sent to the VFDs shall be configured such that 0% speed corresponds to 0 Hz, and 100% speed corresponds to maximum speed configured at the VFD. This does not necessarily correspond to 60 Hz.
  - .4 Provide option for owner to operate Static Pressure Reset and Supply air Temperature Reset in sequence as a lead/lag (with adjustable lead option) as well as concurrent.
- .4 Supply Air Temperature Control
  - .1 The Supply Air temperature control loop is enabled at all times that the supply air fan is proven on, and disabled and output set to deadband (no heating, outdoor air damper closed) otherwise.
  - .2 Supply Air Temperature Set Point. Supply Air Temperature is to be reset and controlled to ASHRAE Guideline 36, using Trim and Respond logic. Design variables are as follows:
    - .1 Minimum Cooling Supply Air Temperature: 12°C (55°F)
    - .2 Maximum Cooling Supply Air Temperature: 18°C (65°F)
    - .3 OAT Minimum: 16°C (60°F)
    - .4 OAT Maximum: 21°C (70°F)
  - .3 Supply air temperature in heating mode shall be kept as low as possible so that heat can be delivered by the VAV reheat coils.
  - .4 All Trim and Respond variables and set points shall be adjustable from the OWS.
  - .5 During occupied mode and setup mode, the SAT set point shall be reset from Minimum Cooling Supply Air Temperature when the OAT is at OAT maximum and above, proportionally up to a maximum temperature, T-max when the outdoor air temperature is at OAT minimum and below. T-max shall not exceed the Maximum Cooling Supply Air Temperature.
  - .6 T-max shall be reset using Trim and Respond Logic between the minimum cooling supply air temperature and the maximum cooling supply air temperature.

.7 See controls diagram from ASHRAE Guideline 36 below:

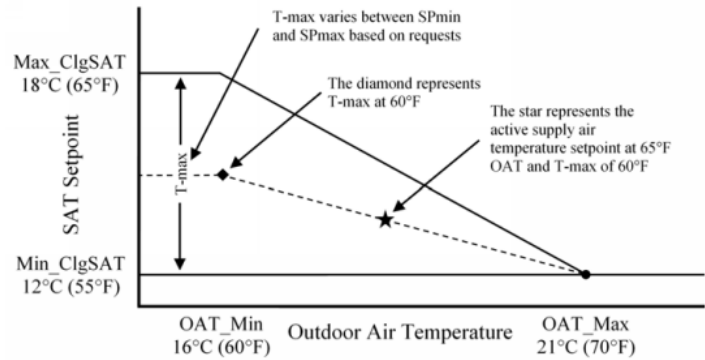


Figure 5.16.2.2 Example supply air temperature reset diagram.

- .8 During the cooldown mode, the set point shall be the minimum cooling supply air temperature.
- .9 During the warm-up and setback modes the set point shall be:
  - .1 35°C (95°F) for systems with zones without reheat.
  - .2 21°C (70°F) for systems with VAV reheat or perimeter heat in all zones.
- .10 Provide logic to allow the VAV unit to act as the primary heat source and increase supply air temperature to 32°C (90°F) in case of central plant failure of branch piping shut down.
- .11 The supply air temperature shall be controlled to set point shall be sent to the AHU.
- .5 Minimum Outdoor Airflow Control
  - .1 ASHRAE Guideline 36 logic shall be modified to allow for CO2 demand control ventilation based on a CO2 reading in the return air duct.
  - .2 The ERV shall be enabled during all occupied hours and represents the minimum ventilation rate. When in minimum ventilation rate, the AHUs OA damper shall be fully closed.
  - .3 The ERV shall be set to free cooling mode when conditions are appropriate.
  - .4 Provide a minimum outdoor air control loop which is enabled whenever the AHU is in operation and in occupied mode. Set output to zero otherwise. Provide an IAQ signal to the unit for internal operation of the dampers, return fan etc.
  - .5 During occupied times:
    - .1 The outdoor air damper will remain closed until a preset value of 1000 ppm is reached. Beyond that value the damper shall modulate open until a minimum value of 800 ppm is reached.
    - .2 Reset the CO2 setpoint up by 200 ppm with the mechanical cooling is in operation.
  - .6 The demand for economizer operation shall override the outdoor air damper position and exhaust/return fan control.
- .6 Air Side Economizer
  - .1 The unit shall control the air side economizer operation.
  - .2 Disable ERV supply fans when unit is operating in economizer mode.
- .7 Paired ERV control
  - .1 Paired ERV shall be operated on a time of day schedule.
  - .2 Exhaust shall run continuously.
  - .3 Supply fan shall run continuously, except for when unit is in economizer mode.



- .4 BAS shall control wheel rotational speed/discharge air temperature setpoint to ensure appropriate air temperature for unit's operating mode. (i.e ERV shall not preheat air that the unit shall cool).
- .5 Monitor ERV via BACnet integration.
- .8 Return Fan and Building Pressure control
  - .1 Return fan shall operate whenever the associated supply fan is proven on, and shall be off otherwise.
  - .2 Return fan shall be controlled to maintain return fan discharge static pressure at set point.
  - .3 Exhaust dampers shall only be enabled when the associated supply and return fans are proven to be on, and the minimum outdoor air damper is open. The exhaust dampers shall be closed otherwise.
  - .4 The building static pressure shall be time averaged with a sliding 5-minute window to dampen fluctuations. The averaged value shall be that displayed and used for control.
  - .5 When exhaust dampers are enabled, a control loop shall modulate exhaust dampers in sequence with the return fan static pressure set point as indicated below to maintain the building pressure at a set point of 12 Pa (0.05 in. of water):
    - .1 From 0% to 50%, the building pressure control loop shall modulate the exhaust dampers from 0% to 100% open.
    - .2 From 51% to 100%, the building pressure control loop shall reset the return-fan discharge static pressure set point from its minimum to maximum. Static set points to be provided by the balancer.
- .4 Alarms
  - .1 Maintenance interval alarm once fan has operated for 1500 hrs.
  - .2 Supply fan status/command mismatch (1 minute delay).
  - .3 Return fan status/command mismatch (1 minute delay).
  - .4 Freeze stat alarms as listed under Limits and Safeties section.
  - .5 Supply air temperature above 35°C (5 minute delay).
  - .6 Return air temperature is more than 5 degrees from space set point (5 minute delay).
  - .7 Unit is running and return air CO2 levels are above 800 ppm (1 hour delay).
  - .8 Heat wheel or other alarm is received from unit controller (immediate).
  - .9 Unit not cooling when commanded, as indicated by SAT (5 minute delay).
  - .10 Unit not heating when commanded, as indicated by SAT (5 minute delay).
  - .11 High Building Pressure (more than 25 Pa (0.10 in. of water)).
  - .12 Low Building Pressure (less than 0 Pa (0.0 in of water)).

#### **.4 Exhaust Fans**

##### **Time Of Day Schedule Control**

These exhaust fans will be controlled through the BAS via a time of day schedule (adjustable, initially set to occupied mode at 06:30 and unoccupied mode at 18:00). Two calendar-based alternate schedules should be set up for this system, in addition to the main schedule. An "Alternate Days" calendar-based schedule (adjustable, initially set up to the same on/off times as the main schedule), and a "Statutory Holidays" calendar-based schedule (adjustable, initially set up to turn this system off on those days) shall be created.

This applies to the following exhaust fans:

- EF-8 Student Washroom
- EF-11 Daycare Washroom
- EF-12 Daycare Washroom

#### Safeties/Alarms

If the exhaust fan status does not match its fan command, an alarm will be sent to the BAS

#### Temperature Control

These exhaust fans will be controlled through the BAS in order to maintain the temperature in the spaces. These exhaust fans are to be interlocked with the heating equipment which is also serving these areas (if applicable), so that the exhaust fan and unit heater are never running simultaneously.

If the zone temperature rises above the zone temperature cooling setpoint (initially set to 26 deg C, adjustable), the exhaust fan command will be enabled. The exhaust fan command shall be hardwired to also control the outdoor air intake damper and the exhaust air damper associated with the exhaust fan (if applicable). The exhaust fan will only start after the intake and exhaust dampers have been confirmed to be fully open. Once the zone temperature drops below the zone temperature cooling setpoint, minus a differential of 2 deg C, the exhaust fan command will be disabled, and the intake and exhaust air dampers closed.

If an operator changes the heating setpoint to a value higher than the exhaust fan cooling setpoint, or if an operator changes the exhaust fan cooling setpoint to a value lower than the heating setpoint, the BAS will automatically shift the unchanged setpoint value so that the 2 setpoints maintain a deadband of 1 deg C, and do not get criss-crossed with each other.

This applies to the following exhaust fans:

- EF-5 Elec Room exhaust
- EF-14 Mech Room exhaust
- EF-13 Boiler Room exhaust

#### Safeties/Alarms

If the zone temperature goes above 30 deg C, an alarm will be sent to the BAS.

If the exhaust fan status does not match its fan command, an alarm will be sent to the BAS.

### **.5 Schneider Electric PowerLogic PM5560 Digital Metering System**

The BAS shall interface with a newly supplied and installed Schneider Electric PowerLogic PM5560 Digital Metering System via Ethernet connection. All of the points listed in the Points List are to be displayed on the BAS. Pulse outputs from all natural gas and water meters are to be wired into this PM5560. All of the required totalization points are to be setup for the applicable points.

A dashboard BAS graphic shall be created to display the metering information

## **.6 Domestic Hot Water Systems**

### Occupied Mode

The occupancy mode will be changed based on a time of day schedule (adjustable, initially set to occupied mode at 06:30 and unoccupied mode at 18:00). The system will also look at any temporary calendars and schedules which are linked to the system (adjustable) to determine which mode the system should be in. Two calendar-based alternate schedules should be set up for this system, in addition to the main schedule. An "Alternate Days" calendar-based schedule (adjustable, initially set up to the same on/off times as the main schedule), and a "Statutory Holidays" calendar-based schedule (adjustable, initially set up to turn this system off on those days) shall be created.

The domestic hot water recirculating pumps will be enabled, and will run continuously in occupied mode through BAS.

The heater's local controls will maintain the hot water discharge at setpoint.

### Unoccupied Mode

The domestic hot water recirculating pumps will be disabled, and will not run in unoccupied mode through BAS.

The heater's local controls will maintain the hot water discharge at setpoint.

### Safeties/Alarms

If either domestic hot water supply temperature goes above 70 deg C or below 40 deg C, an alarm will be sent to the BAS.

If the tempered hot water supply temperature goes above 55 deg C or below 40 deg C, an alarm will be sent to the BAS.

If any of the domestic hot water recirculating pump statuses do not match their associated pump command, an alarm will be sent to the BAS.

## **.7 Radiation and/or Radiant Panels**

The mode of operation for the radiation valves will be based on a time of day schedule (adjustable). The rads will also look at any temporary calendars and schedules (adjustable) to determine which mode they should be in.

In occupied mode, if the zone temperature drops below the zone occupied heating setpoint (22 deg C, adjustable), the radiation valve will be modulated open to satisfy the setpoint.

In unoccupied mode, if the zone temperature drops below the zone unoccupied heating setpoint (18 deg C, adjustable), the radiation valve will be modulated open to satisfy the setpoint.

### Safeties/Alarms

If the zone temperature is above or below the alarm levels (adjustable), an alarm will be sent to the BAS.

## **.8 Lighting Control**

### Outdoor Lighting/Plug BAS Override Control

BAS to interface and control exterior lights and corridor/stairwell lights thru Hand/Off/Auto contactor provided by the electrical contractor.

#### EXTERIOR LIGHTS

1. BAS to control all exterior lights ON/OFF through a H/A/O (Hand/Auto/Off) contactor based on solar clocks and scheduling.
2. There are to be 15-minute delays before the sun sets and after the sun rises. A typical school schedule Monday-Friday is 5:45am ON – 10:15pm OFF.
3. Photocells and third-party lighting panels are not to be used.

#### CORRIDOR AND STAIRWELL LIGHTS

1. BAS to control all corridor lights ON/OFF based off security panel output through a H/A/O (Hand/Auto/Off) contactor.
2. Hand mode - Corridor lights are ON regardless of BAS command.
3. Off mode - Corridor lights are OFF regardless of BAS command.
4. Auto mode – Corridor lights turn ON and OFF based on BAS command. If the system is armed, then corridor lights are OFF. If system is disarmed, all corridor lights are ON.
5. Motion sensors on corridor lights dim to 50% if no motion is detected after 10 minutes.
6. Upon a triggered burglar alarm when the system is armed, alarm output is sent to BAS. BAS will then turn ON all corridor lights until the alarm is cleared or the system is disarmed.
7. Security panel to send BAS the armed/disarmed status and alarm information.
8. Lights are to be programmed to operate based on the above sequence.

Provide programmable control of seven (7) lighting control circuits through the OWS. Connect to nearest electrical lighting control panel where indicated:

- Exterior lighting Pole/Building, 3 points
- Fire alarm signal, 1 point
- Interior lighting, 2 points
- Receptacle Control, 3 points

### Safeties/Alarms

If the BAS enable command for any of the lighting circuits is disabled, but the corresponding circuit's status indicates that the lights are on, an alarm will be sent to the BAS

## **.9 Cabinet Unit Heaters & Horizontal Unit Heaters**

A temperature sensor (provided by the BAS contractor) energizes the fan to maintain setpoint. Provide status on fan.

Via the BAS, the units will be disabled when the hot water heating system is disabled, and will be enabled when the hot water heating system is enabled.

In occupied mode, if the zone temperature drops below the zone occupied heating setpoint (22°C, adjustable), the radiation valve will be modulated open to satisfy the setpoint.

In unoccupied mode, if the zone temperature drops below the zone unoccupied heating setpoint (18°C, adjustable). The radiation valve will be modulated open to satisfy the setpoint.

### Safeties/Alarms

If the zone temperature is above or below the alarm levels (adjustable), an alarm will be sent to the BAS.

## **.10 VAV Terminal with Reheat**

### **.1 General**

- .1 Controls logic to be provided to meet ASHRAE Guideline 36, High-Performance Sequences of Operation for HVAC Systems. A summary of this standard follows, but BAS contractor remains responsible for the full implementation of the standard along with any additional notes indicated below.
- .2 Design flow rates are indicated on the VAV Schedule on the drawings. Controls contractor shall calculate all required airflow settings as indicated elsewhere in this section. All settings shall be independently adjustable by the operator.
- .3 Supply air temperature shall be monitored and displayed at the OWS.
- .4 Supply air volume shall be monitored and displayed at the OWS.
- .5 Space temperature sensors are equipped with a warm/cool adjust and occupancy override button.
- .6 All set points shall be adjustable. Refer to schedules for maximum and minimum airflows in different operating modes.

### **.2 Safeties and Limits**

- .1 The discharge air temperature shall be controlled to be no greater than 30 degrees F above the space set point.

### **.3 System Start/Stop. Not applicable. Refer to multizone AHU sequences of operation.**

### **.4 Control Strategy**

- .1 Active maximum and minimum air flow set points shall vary depending on the mode of the zone group the VAV is a part of.

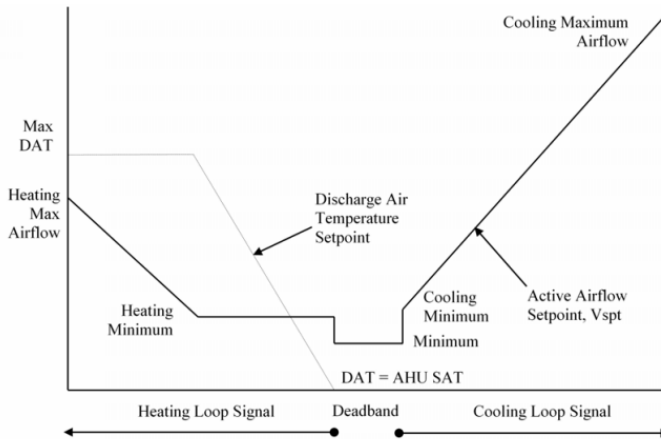
Set Point	Occupied	Cool down	Warm-Up	Unoccupied
Cooling Maximum	Vcool-max	Vcool-max	0	0
Cooling Minimum	Vcool-min	0	0	0
Minimum	Vmin	0	0	0
Heating Minimum	Larger of Vheat-min or Vmin	Heating Minimum	Heating Maximum	0
Heating Maximum	Larger of Vheat-max or Vmin	Heating Maximum	Cooling Maximum	0

- .2 Maximum and minimum airflows shall be set as follows:

- .1 Vcool-max: Design airflow, plus 30%
- .2 Vcool-min: 30% of design airflow

- .3 Vheat-max: 80% of design airflow.
- .4 Vheat-min: 0 cfm
- .5 Vmin: 30% of design airflow

.3 Control logic is depicted schematically in the figure below and described in the following sections.



- .4 Cooling Zone State: The cooling loop output shall be mapped to the airflow set point from the cooling minimum to the cooling maximum set points. Heating coil is disabled unless discharge air temperature is below the minimum set point. Note that if the supply air temperature from the air handler is greater than room temperature, cooling supply airflow set point shall be no higher than the minimum.
- .5 Deadband Zone State: The active airflow set point shall be the minimum airflow set point. Heating coil is disabled unless the discharge air temperature is below the minimum set point.
- .6 Heating Zone State: The heating loop shall maintain space temperature at the heating set point as follows:
  - .1 From 0 to 50%, the heating loop output shall reset the discharge air temperature set point from the current AHU SAT set point to the maximum above space temperature set point (30°F). The airflow setpoint shall be the heating minimum.
  - .2 From 51% to 100%, if the DAT is greater than the room temperature plus 3°C (5°F), the heating loop output shall reset the airflow set point from the heating minimum airflow set point to the heating maximum airflow set point.
  - .3 The heating coil shall be modulated to maintain the discharge air temperature set point.
- .7 System Requests
  - .1 Cooling SAT reset requests
    - .1 If the zone temperature exceeds the zone's cooling set point by 3°C (5°F) for 2 minutes, send 3 requests.
    - .2 Else if zone temperature exceeds the zone's cooling set point by 2°C (3°F) for 2 minutes, send 2 requests.
    - .3 Else if the cooling loop is greater than 95%, send 1 request until the loop is less than 85%.
    - .4 Else if the cooling loop is less than 95%, send 0 requests.
    - .5 Repress requests for 5 minutes after a reset to the SAT.
    - .6 Reset requests shall only adjust the Tmax variable in the SAT reset curve.
  - .2 Static Pressure reset requests

- .1 If the measured airflow is less than 50% of set point while set point is greater than zero and the damper position is greater than 95% for 1 minute, send 3 requests.
- .2 Else if the measured airflow is less than 70% of set point while set point is greater than zero and the damper position is greater than 95% for 1 minute, send 2 requests.
- .3 Else if the damper position is greater than 95%, send 1 request until the damper position is less than 85%.
- .4 Else if the damper is less than 95%, send 0 requests.
- Repress requests for 5 minutes after a reset to the static pressure.
- .3 Hot Water reset requests
  - .1 If the DAT is 17°C (30°F) less than set point for 5 minutes, send 3 requests.
  - .2 If the DAT is 8°C (15°F) less than set point for 5 minutes, send 2 requests.
  - .3 Else if HW valve position is greater than 95%, send 1 request until the HQ valve position is less than 85%.
  - .4 Else if the HW valve position is less than 95%, send 0 requests.
  - .5 Repress requests for 5 minute after a reset to the hot water temperature.
  - .6 Hot water reset requests shall move the hot water reset curve up and down between it's maximum and minimum values.
- .5 Alarms
  - .1 Low Airflow
    - .1 Measured airflow is less than 70% of set point for 5 minutes (while set point is greater than 0).
    - .2 Measured airflow is less than 50% of set point for 5 minutes (while set point is greater than 0).
    - .3 If a zone has an importance-multiplier of 0 for it's static pressure reset control loop, low airflow alarms shall be suppressed.
  - .2 Low-Discharge Air Temperature
    - .1 If heating plant is on, and DAT is 8°C (15°F) less than set point for 10 minutes.
    - .2 If heating plant is on, and DAT is 17°C (30°F) less than set point for 10 minutes.
    - .3 If a zone has an importance multiplier of 0 for it's hot water reset control loop, low discharge air temperature alarms shall be suppressed.
    - .4 Airflow Sensor Calibration: If the fan serving the zone has been off for 10 minutes and the airflow sensor reading is above 10% of the cooling maximum airflow set point.
    - .5 Leaking Damper: If the damper position is 0% and airflow sensor is above 10% of the cooling maximum airflow set point for 10 minutes while the fan serving the zone is on.
    - .6 Leaking Valve: If the valve position is 0% for 15 minutes, DAT is above AHU SAT by 3°C (5°F) and the fan serving the zone is on.

## **.11 Control Valve Exercising**

All control valves shall be fully opened and closed once per week during unoccupied hours. Stagger open/closing so as to not disrupt ongoing system operation and pumping.

## **.12 Mechanical Room Control**

Provide space sensor to control motorized damper, exhaust fan, and unit heater.

On rise in space temperature the exhaust fan(s) and motorized damper where installed are energized.

On drop in space temperature the unit heater is energized.

#### Safeties/Alarms

If the zone temperature is above or below the alarm levels (adjustable), an alarm will be sent to the BAS.

### **.13 Phase Loss Detection**

Provide current sensing relays on the BUSS in each MCC at the dedicated section.

At loss of power, turn off all connected equipment. Sequence equipment on when power is restored.

#### Safeties/Alarms

Provide alarm at OWS on loss of power.

### **.14 BAS-To-Security Panel**

- .1 Provide digital input from security system.
- .2 Upon a triggered burglar alarm when the system is armed, alarm output is sent to BAS. BAS will then turn ON all corridor lights until the alarm is cleared and the system disarmed.
- .3 Security panel to send BAS the armed/disarmed status and alarm information. Lights are to be programmed to operate on the above sequence.
- .4 When building security armed all AHU's, Exhaust Fans, and heating systems shall be changed to unoccupied mode immediately when armed regardless of scheduled times.
- .5 All critical alarms as determined by the Owner and/or the Owner Representative to be sent to security via a digital output.
- .6 BAS to control all corridor and exterior lights ON/OFF based off security panel output through H/A/O contactor.

Two extra sets of 2-wire control wiring shall be installed from the BAS to the Security Panel for future alarm points.

### **.15 Main Gas & Water Consumption Metering**

The main incoming gas consumption meter, main incoming water consumption meter, and boiler make-up water meter shall be supplied by the mechanical contractor, and installed by the mechanical contractor. These meters shall provide a pulse output for connection to the PM5560 Digital Metering System. These meters shall be connected to the BAS for monitoring and totalizing. Please see the "Schneider Electric PowerLogic PM5560 Digital Metering System" sequence of operation section above for details on adding these gas and water meters to the BAS dashboard graphic page.

### **.16 Fire Alarm Panel**

Provide connection to fire alarm panel.

#### **.1 FIRE ALARM INTEGRATION**

- .1 The fire panel monitoring consists of one dry contact at fire alarm panel as supplied by panel



manufacturer.

- .2 The DDC will monitor fire panel contact and generate an alarm if contact closes.
- .3 The BAS/DDC system will enter fire alarm system mode as approved by local fire authority and mechanical engineer.
- .4 Points List

1. Name	1. AI	1. AO	1. DI	1. DO
1. System Status	1.	1.	1. X	1.

#### **.17 Library Destratification Fan (Gym Similar)**

Enable/disable destratification fan based on time of day schedule (refer to plans for multiple locations).

Connect to controller as indicated on mechanical plans.

#### **.18 Individual Room Control (Reheat Coil)**

The space temperature sensor modulates the 2-way reheat coil heating valve to maintain setpoint. Provide setback setpoint for unoccupied periods.

#### Safeties/Alarms

If the zone temperature is above or below the alarm levels (adjustable), an alarm will be sent to the BAS.

## APPENDIX B Glossary of Terms

### 1.1 Terms used within the Specification Text

- **Advanced Application Controller (AAC):**

A fully programmable control module. This control module may be capable of some of the advanced features found in Building Controllers (storing trends, initiating read and write requests, etc.) but it does not serve as a master controller. Advanced Application Controllers may reside on either the Ethernet/IP backbone or on a subnet.

- **Application Specific Controller (ASC):**

A pre-programmed control module which is intended for use in a specific application. ASCs may be configurable, in that the user can choose between various pre-programmed options, but it does not support full custom programming. ASCs are often used on terminal equipment such as VAV boxes or fan coil units. In many vendors' architectures ASCs do not store trends or schedules but instead rely upon a Building Controller to provide those functions.

- **BACnet/IP:**

An approved BACnet network type which uses an Ethernet carrier and IP addressing.

- **BACnet MS/TP:**

An approved BACnet network type which uses a Master-Slave Token Passing configuration. MS/TP networks are unique to BACnet and utilize EIA485 twisted pair topology running at 9600 to 76,800 bps.

- **BACnet over ARCNET:**

An approved BACnet network type which uses an ARCNET (attached resource computer network) carrier. ARCNET is an industry standard that can utilize several speeds and wiring standards. The most common configuration used by BACnet controllers is an EIA485 twisted pair topology running at 156,000 bps.

- **Building Controller (BC):**

A fully programmable control module which is capable of storing trends and schedules, serving as a router to devices on a subnet, and initiating read and write requests to other controllers. Typically this controller is located on the Ethernet/IP backbone of the BAS. In many vendors' architectures a Building Controller will serve as a master controller, storing schedules and trends for controllers on a subnet underneath the Building Controller.

- **Direct Digital Control (DDC):**

A control system in which a digital computer or microprocessor is directly connected to the valves, dampers, and other actuators which control the system, as opposed to indirectly controlling a system by resetting setpoints on an analog pneumatic or electronic controller.

- **PICS - Protocol Implementation Conformance Statement:**

A written document, created by the manufacturer of a device, which identifies the particular options specified by BACnet that are implemented in the device.

- **Smart Actuator (SA):**

An actuator which is controlled by a network connection rather than a binary or analog signal. (0-10v, 4-20mA, relay, etc.)

- **Smart Sensor (SS):**

A sensor which provides information to the BAS via network connection rather than a binary or analog signal. (0-10000 ohm, 4-20mA, dry contact, etc.)

- **Web Services:**

Web services are a standard method of exchanging data between computer systems using the XML (extensible markup language) and SOAP (simple object access protocol) standards. Web services can be used at any level within a Building Automation System (BAS), but most commonly they are used to transfer data between BAS using different protocols or between a BAS and a non-BAS system such as a tenant billing system or a utility management system.

## 1.2 Terms used within the Sequences of Operation

- **adj.:**

Adjustable by the end user, through the supplied user interface.

- **AI, AO, etc. (Column Headings on Points List)**

**AI** = Analog Input. A physical input to the control module.

**AO** = Analog Output. A physical output from the control module.

**AV** = Analog Variable. An intermediate (software) point that may be editable or read-only. Editable AVs are typically used to allow the user to set a fixed control parameter, such as a setpoint. Read Only AVs are typically used to display the status of a control operation.

**BI** = Binary Input. A physical input to the control module.

**BO** = Binary Output. A physical output from the control module.

**BV** = Binary Variable. An intermediate (software) point that may be editable or read-only. Editable BVs are typically used to allow the user to set a fixed control parameter, such as a setpoint. Read Only BVs are typically used to display the status of a control operation.

**Sched** = Schedule. The control algorithm for this equipment shall include a user editable schedule.

**Trend**. The control system shall be configured to collect and display a trend log of this object. The trending interval shall be no less than one sample every 5 minutes. (Change of Value trending, where a sample is taken every time the value changes by more than a user-defined minimum, is an acceptable alternative.)

**Alarm**. The control system shall be configured to generate an alarm when this object exceeds user definable limits, as described in the Sequence of Controls.

**Note:** If the specifications require use of the BACnet protocol, all of the above shall be provided as BACnet objects.

- **KW Demand Limiting: \***

An energy management strategy that reduces energy consumption when a system's electric power meter exceeds an operator-defined threshold.

When power consumption exceeds defined levels, the system automatically adjust setpoints, de-energizes low priority equipment, and takes other pre-programmed actions to avoid peak demand charges. As the demand drops, the system restores loads in a predetermined manner.

- **Occupant Override Switch, or Timed Local Override:**

A control option that allows building occupants to override the programmed HVAC schedule for a limited period of time.

When the override time expires, the zone returns to its unoccupied state.

- **Occupant Setpoint Adjustment:**

A control option that allows building occupants to adjust - within limits set by the HVAC control system - the heating and cooling setpoints of selected zones. Typically the user interface for this function is built into the zone sensor.

- **Optimal Start-Up: \***

A control strategy that automatically starts an HVAC system at the latest possible time yet ensures comfort conditions by the time the building becomes occupied.

In a typical implementation, a controller measures the temperature of the zone and the outside air. Then, using design heating or cooling capacity at the design outside air temperature, the system computes how long a unit must run at maximum capacity to bring the zone temperature to its occupied setpoint.

The optimal start algorithm often includes a self-learning feature to adjust for variations from design capacity.

A distributed system must use Run on Request with Optimal Start. (See below.)

**Requested, or Run on Request: \***

A control strategy that optimizes the runtime of a source piece of equipment that supplies one or more receiving units - such as an air handler unit supplying zone terminal units with heating, cooling, ventilation, or similar service. Source equipment runs only when needed, not on a fixed schedule.

The source equipment runs when one or more receiving units request its services. An operator determines how many requests are required to start the source equipment.

For example, if all the zones in a building are unoccupied and the zone terminal units do not need heating or cooling, the AHU will shut down. However, if a zone becomes occupied or needs cooling, the terminal unit will send a run request to the AHU to initiate the start-up sequence. If this AHU depends on a central chiller, it can send a run request to the chiller.

The run on request algorithm also allows an operator to schedule occupancy for individual zones based on the needs of the occupants without having to adjust the schedules of related AHUs and chillers.

- **Trim and Respond, or Setpoint Optimization: \***

A control strategy that optimizes the setpoint of a source piece of equipment that supplies one or more receiving units - such as an air handler unit supplying zone terminal units with heating, cooling, ventilation, or similar service.

The source unit communicates with receiving units to determine heating, cooling, and other requirements, and then adjusts its setpoint.

For example, if all zones are comfortable and do not request cooling, the AHU will gradually increase (trim) its supply air setpoint. When a zone requests cooling, the AHU responds by dropping its setpoint. The more zones that request cooling, the more it drops the setpoint. The AHU repeats this process throughout the day to keep zones cool, but with a supply air setpoint that is no cooler than necessary.

### **1.3 Contracting Terms**

- **Furnished or Provided:**

The act of supplying a device or piece of equipment as required meeting the scope of work specified and making that device or equipment operational. All costs required to furnish the specified device or equipment and make it operational are borne by the division specified to be responsible for providing the device or equipment.

- **Install or Installed:**

The physical act of mounting, piping or wiring a device or piece of equipment in accordance with the manufacturer's instructions and the scope of work as specified. All costs required to complete the installation are borne by the division specified to include labor and any ancillary materials.

**Interface:**

The physical device required to provide integration capabilities from an equipment vendor's product to the control system. The equipment vendor most normally furnishes the interface device. An example of an interface is the chilled water temperature reset interface card provided by the chiller manufacturer in order to allow the control system to integrate the chilled water temperature reset function into the control system.

- **Integrate:**

The physical connections from a control system to all specified equipment through an interface as required to allow the specified control and monitoring functions of the equipment to be performed via the control system.

## **APPENDIX C     Abbreviations**

The following abbreviations may be used in graphics, schematics, point names, and other UI applications where space is at a premium:

**AC** - Air Conditioning  
**ACU** - Air Conditioning Unit  
**AHU** - Air Handling Unit  
**AI** - Analog Input  
**AO** - Analog Output  
**AUTO** - Automatic  
**AUX** - Auxiliary  
**BI** - Binary Input  
**BO** - Binary Output  
**C** - Common  
**CHW** - Chilled Water  
**CHWP** - Chilled Water Pump  
**CHWR** - Chilled Water Return  
**CHWS** - Chilled Water Supply  
**COND** - Condenser  
**CW** - Condenser Water  
**CWP** - Condenser Water Pump  
**CWR** - Condenser Water Return  
**CWS** - Condenser Water Supply  
**DA** - Discharge Air  
**EA** - Exhaust Air  
**EF** - Exhaust Fan  
**EVAP** - Evaporators  
**FCU** - Fan Coil Unit  
**HOA** - Hand / Off / Auto  
**HP** - Heat Pump  
**HRU** - Heat Recovery Unit  
**HTEX** - Heat Exchanger  
**HW** - Hot Water  
**HWP** - Hot Water Pump  
**HWR** - Hot Water Return  
**HWS** - Hot Water Supply  
**MAX** - Maximum  
**MIN** - Minimum  
**MISC** - Miscellaneous  
**NC** - Normally Closed  
**NO** - Normally Open  
**OA** - Outdoor Air  
**PIU** - Powered Induction Unit  
**RA** - Return Air  
**RF** - Return Fan  
**RH** - Relative Humidity  
**RTU** - Roof-top Unit  
**SA** - Supply Air  
**SF** - Supply Fan  
**SP** - Static Pressure  
**TEMP** - Temperature

**UH** - Unit Heater

**UV** - Unit Ventilator

**VAV** - Variable Air Volume

**VVTU** - Variable Volume Terminal Unit

**W/** - with

**W/O** - without

**WSHP** - Water Source Heat Pump

## **APPENDIX D     Points List**

Points listed in the Points List are to be included on the BAS system, utilizing the Point Names and Point Descriptions as they appear in the Points List. Additional points may be added, but the Points in the Points List are to be included at a minimum.

The points list appended here to shall be read in conjunction with the drawings and specification. Should the control functions be indicated in the specification and not indicated on the points list or indicated in the points list and not in the specification, it does not relieve the contractor in providing a complete system. It is the contractor's responsibility to ensure the BAS system is installed and operates as specified.



## POINTS LIST

Point Name	Point Description	Analog Inputs	Analog Outputs	Binary Inputs	Binary Outputs	Analog Variables	Binary Variables	Schedule/Calendar	Trend	Alarm	Show On Graphic
<b>Hot Water Boiler System</b>											
555.BLR.OA-T	Outdoor Air Temp	x							x		x
555.BLR.OA-H	Outdoor Air Humidity	x							x		x
555.BLR.OA-CO2	Outdoor Air Carbon Dioxide	x							x		x
555.BLR.PHWS-T	Primary Hot Water Supply Temp	x							x	x	x
555.BLR.PHWR-T	Primary Hot Water Return Temp	x							x	x	x
555.BLR.BLR1-HWS-T	Boiler 3 Hot Water Supply Temp	x							x		x
555.BLR.HW-DP	Heating Loop Differential Pressure	x							x		x
555.BLR.BLR1-O	Boiler 3 Demand Output		x						x		x
555.BLR.C1-O	Boiler Pump C-3 Output		x						x		x
555.BLR.BLR1-S	Boiler 3 Run Status			x					x	x	x
555.BLR.BLR1-A	Boiler 3 General Alarm Status			x					x	x	x
555.BLR.C1-S	Boiler Pump C-3 Status			x					x	x	x
555.BLR.BLRWTR-M	Boiler System Makeup Water Meter			x					x	x	x
555.BLR.NOHEAT-ALM-SILENCE	"No Heat" Security Alarm Silence Switch			x					x		x
555.BLR.BLR1-EN	Boiler 3 Enable Command				x				x		x
555.BLR.C1-C	Boiler Pump C-3 Command				x				x		x
555.BLR.NOHEAT-ALM	"No Heat" Security Alarm Output				x				x	x	x
555.BLR.NOHEAT-ALM -LIGHT	"No Heat" Security Alarm Local Light Output				x				x		x
555.BLR.NOHEAT-ALM -HORN	"No Heat" Security Alarm Local Horn Output				x				x		x
555.BLR.CALC-PHWST-SP	Calculated PHWS-T Setpoint					x			x		x
555.BLR.PHWSTSP-LO-OAT	PHWS-T Setpoint - Low OA-T Value					x					
555.BLR.PHWSTSP-HI-PHWSTSP	PHWS-T Setpoint - High PHWST-SP Value					x					
555.BLR.PHWSTSP-HI-OAT	PHWS-T Setpoint - High OA-T Value					x					
555.BLR.PHWSTSP-LO-PHWSTSP	PHWS-T Setpoint - Low PHWST-SP Value					x					
555.BLR.OAT-BLRSYS-EN-SP	OA-T Boiler System Enable Setpoint					x					x
555.BLR.BLR1-HWST-HI-SP	Boiler 3 HWS-T High Limit Temp Setpoint					x					x
555.BLR.NOHEAT-SP	PHWR-T "No Heat" Security Alarm Setpoint					x					x
555.BLR.HW-DP-SP	Heating Loop Diff Pressure SP					x					x
555.BLR.BLR1-RUNTIME	Boiler 3 Runtime Hours					x			x		x
555.BLR.BLRSYS-MAN-EN	Boiler System Manual Enable						x				x
555.BLR.BLRSYS-CAL-EN	Boiler System Calendar Enable						x	x			x

Point Name	Point Description	Analog Inputs	Analog Outputs	Binary Inputs	Binary Outputs	Analog Variables	Binary Variables	Schedule/Calendar	Trend	Alarm	Show On Graphic
<b>Perimeter Heating Loop</b>											
555.PRLOOP.PRS-T	Perimeter Heat Loop Supply Temp	x							x	x	x
555.PRLOOP.PRR-T	Perimeter Heat Loop Return Temp	x							x	x	x
555.PRLOOP.PR-DP	Perimeter Heat Loop Differential Pressure (x2)	x							x	x	x
555.PRLOOP.C-3-O	Perimeter Heating Loop Pump C-6 Output		x						x		x
555.PRLOOP.C-4-O	Perimeter Heating Loop Pump C-7 Output		x						x		x
555.PRLOOP.C-3-S	Perimeter Heating Loop C-6 Status			x					x	x	x
555.PRLOOP.C-7-S	Perimeter Heating Loop C-7 Status			x					x	x	x
555.PRLOOP.C-3-C	Perimeter Heating Pump C-6 Enable				x						x
555.PRLOOP.C-4-C	Perimeter Heating Loop Pump C-7 Enable				x						x
555.PRLOOP.C3VFD-C	Heat Pump Loop C-6 VFD		x						x		x
555.PRLOOP.C4VFD-C	Heat Pump Loop C-7 VFD		x						x		x
555.PRLOOP.OA-T	Outdoor Air Temp					x					x
555.PRLOOP.NOHEAT-SP	Perimeter Heating Loop "No Heat" Security Alarm Setpoint					x					x
555.PRLOOP.NOHEAT-ALM	"No Heat" Security Alarm Output						x		x	x	x
555.PRLOOP.PRLOOP-CAL-EN	Perimeter Heating Loop System Calendar Enable						x	x			x
555.HVAC-X.UNOCC-HTG-SP	Unoccupied Mode Zone Heating Setpoint					x					x
555.HVAC-X.UNOCC-CLG-SP	Unoccupied Mode Zone Cooling Setpoint					x					x
555.HVAC-X.OA-CO2	Outdoor Air Carbon Dioxide					x			x		x
555.HVAC-X.CALC-RA-CO2-SP	Calculated Return Air Carbon Dioxide					x			x		x
555.HVAC-X.OCC-MODE	Occupancy Mode Point						x	x	x		x

Point Name	Point Description	Analog Inputs	Analog Outputs	Binary Inputs	Binary Outputs	Analog Variables	Binary Variables	Schedule/Calendar	Trend	Alarm	Show On Graphic
<b>HVAC-1, 2, 3</b>											
555.HVAC-X.DA-T	Discharge Air Temp	x							x		x
555.HVAC-X.MA-T	Mixed Air Temp	x							x		x
555.HVAC-X.RA-T	Return Air Temp	x							x	x	x
555.HVAC-X.HR-DA-T	Energy Recovery Discharge Air Temp (HVAC-1 & 2 Only)	x							x		x
555.HVAC-X.HR-EA-T	Energy Recovery Exhaust Air Temp (HVAC-1 & 2 Only)	x							x		x
555.HVAC-X.DA-H	Discharge Air Humidity	x							x		x
555.HVAC-X.RA-H	Return Air Humidity	x							x		x
555.HVAC-X.RA-CO2	Return Air Carbon Dioxide	x							x	x	x
555.HVAC-X.MAD-O	Mixed Air Dampers Output		x						x		x
555.HVAC-X.EAD-O	Exhaust Air Dampers Output		x						x		x
555.HVAC-X.HTG-O	Gas Valve Output		x						x		x
555.HVAC-X.SF-S	Supply Fan Status			x					x	x	x
555.HVAC-X.RF-S	Return Fan Status			x					x	x	x
555.HVAC-X.FILTER-S	Filter Status			x					x	x	x
555.HVAC-X.COMP-S	Compressor Status			x					x		x
555.HVAC-X.TEMPOCC-S	Temp Occ Status			x					x		x
555.HVAC-X.MAT-LO-ALM	Mixed Air Temp Low Limit Alarm			x					x	x	x
555.HVAC-X.SF-C	Supply Fan Command				x						x
555.HVAC-X.RF-C	Return Fan Command				x						x
555.HVAC-X.SFVFD-C	Supply Fan VFD		x								x
555.HVAC-X.RFVFD-C	Return Fan VFD		x								x
555.HVAC-X.CLG1-C	DX Cooling Stage 1 Enable				x						x
555.HVAC-X.CLG2-C	DX Cooling Stage 2 Enable				x						x
555.HVAC-X.CLG3-C	DX Cooling Stage 3 Enable				x						x
555.HVAC-X.CLG4-C	DX Cooling Stage 4 Enable				x						x
555.HVAC-X.SA-Z1-F	2nd Floor Supply Air Flow (if applicable)	x							x		x
555.HVAC-X.SA-Z2-F	Ground Floor Supply Air Flow (if applicable)	x							x		x
555.HVAC-X.RA-Z1-F	2nd Floor Return Air Flow (if applicable)	x							x		x
555.HVAC-X.RA-Z2-F	Ground Floor Return Air Flow (if applicable)	x							x		x
555.HVAC-X.OA-T	Outdoor Air Temp					x					x
555.HVAC-X.MAD-MINPOS-SP	Mixed Air Dampers Minimum Position Setpoint					x					x
555.HVAC-X.MAT-LO-SP	Mixed Air Temp Low Limit Setpoint					x					x
555.HVAC-X.CALC-DAT-SP	Calculated Discharge Air Temp Setpoint					x			x		x
555.HVAC-X.DAT-SP-LO	Discharge Air Temp Setpoint Low Limit					x			x		x
555.HVAC-X.DAT-SP-HI	Discharge Air Temp Setpoint High Limit					x			x		x
555.HVAC-X.RACO2-SP	Return Air Carbon Dioxide Setpoint					x					x
555.HVAC-X.UNOCC-HTG-SP	Unoccupied Mode Zone Heating Setpoint					x					x
555.HVAC-X.UNOCC-CLG-SP	Unoccupied Mode Zone Cooling Setpoint					x					x
555.HVAC-X.OA-CO2	Outdoor Air Carbon Dioxide					x			x		x
555.HVAC-X.CALC-RA-CO2-SP	Calculated Return Air Carbon Dioxide					x			x		x
555.HVAC-X.WHL-S	Energy Recovery Wheel Status	x							x	x	x
555.HVAC-X.OCC-MODE	Occupancy Mode Point						x	x	x		x
<b>Exhaust Fans (Time Of Day Schedule Controlled)</b>											

Point Name	Point Description	Analog Inputs	Analog Outputs	Binary Inputs	Binary Outputs	Analog Variables	Binary Variables	Schedule/Calendar	Trend	Alarm	Show On Graphic
555.DF-x.RM.DFx-S (Multiple)	Exhaust Fan Status			x					x	x	x
555.DF-x.RM.DFx-C (Multiple)	Exhaust Fan Command				x			x	x		x
<b>Exhaust Fans (Temperature Controlled)</b>											
555.EF-3.RM117.ZN-T	Zone Temperature	x							x	x	x
555.EF-3.RM117.EF3-S	Exhaust Fan Status			x					x	x	x
555.EF-3.RM117.EF3-C	Exhaust Fan Command				x				x		x
555.EF-3.RM1170.CLG-SP	Zone Cooling Setpoint					x					x
555.EF-4.RMvvv.ZN-T	Zone Temperature (Multiple Rooms)	x							x	x	x
555.EF-4.RMvvv.EF4-S	Exhaust Fan Status (Multiple Rooms)			x					x	x	x
555.EF-4.RMvvv.EF4-C	Exhaust Fan Command (Multiple Rooms)				x				x		x
555.EF-4.RMvvv.CLG-SP	Zone Cooling Setpoint (Multiple Rooms)					x					x
555.EF-6.RM211.ZN-T	Zone Temperature	x							x	x	x
555.EF-6.RM211.FFH-EN	Horizontal Unit Heater (H-7) Enable Command				x				x		x
555.EF-6.RM211.EF7-S	Exhaust Fan Status			x					x	x	x
555.EF-6.RM211.EF7-C	Exhaust Fan Command				x				x		x
555.EF-6.RM211.CLG-SP	Zone Cooling Setpoint					x					x
555.EF-5.RM211.HTG-SP	Zone Heating Setpoint					x					x
555.EF-5.RM129.ZN-T	Zone Temperature	x							x	x	x
555.EF-5.RM129.EF5-S	Exhaust Fan Status			x					x	x	x
555.EF-5.RM129.EF5-C	Exhaust Fan Command				x				x		x
555.EF-5.RM129.CLG-SP	Zone Cooling Setpoint					x					x
<b>DM5560 Digital Metering System</b>											
555.METER.ELECTRIC.VOLTS-A-N	Voltage - Phase A To Neutral (V)					x			x		x
555.METER.ELECTRIC.VOLTS-B-N	Voltage - Phase B To Neutral (V)					x			x		x
555.METER.ELECTRIC.VOLTS-C-N	Voltage - Phase C To Neutral (V)					x			x		x
555.METER.ELECTRIC.VOLTS-L-N-AVG	Voltage - Phase To Neutral Average (V)					x			x		x
555.METER.ELECTRIC.VOLTS-A-B	Voltage - Phase A To Phase B (V)					x			x		x
555.METER.ELECTRIC.VOLTS-A-C	Voltage - Phase A To Phase C (V)					x			x		x
555.METER.ELECTRIC.VOLTS-B-C	Voltage - Phase B To Phase C (V)					x			x		x
555.METER.ELECTRIC.VOLTS-L-L-AVG	Voltage - Phase To Phase Average (V)					x			x		x
555.METER.ELECTRIC.AMPS-A	Current - Phase A (A)					x			x		x
555.METER.ELECTRIC.AMPS-B	Current - Phase B (A)					x			x		x
555.METER.ELECTRIC.AMPS-C	Current - Phase C (A)					x			x		x
555.METER.ELECTRIC.AMPS-C	Current - Neutral (A)					x			x		x
555.METER.ELECTRIC.AMPS-AVG	Current - Average (A)					x			x		x
555.METER.ELECTRIC.DMD-TOT	Demand - Total (kW)					x			x		x
555.METER.ELECTRIC.DMD-AVG	Demand - Average (kW)					x			x		x
555.METER.ELECTRIC.DMD-A	Demand - Phase A (kW)					x			x		x
555.METER.ELECTRIC.DMD-B	Demand - Phase B (kW)					x			x		x
555.METER.ELECTRIC.DMD-C	Demand - Phase C (kW)					x			x		x
555.METER.ELECTRIC.DMD-PEAK	Demand - Peak (kW)					x			x		x
555.METER.ELECTRIC.DMD-PEAK-A	Demand - Phase A Peak (kW)					x			x		x
555.METER.ELECTRIC.DMD-PEAK-B	Demand - Phase B Peak (kW)					x			x		x
555.METER.ELECTRIC.DMD-PEAK-C	Demand - Phase C Peak (kW)					x			x		x

Point Name	Point Description	Analog Inputs	Analog Outputs	Binary Inputs	Binary Outputs	Analog Variables	Binary Variables	Schedule/Calendar	Trend	Alarm	Show On Graphic
555.METER.ELECTRIC.DMD-INTERVAL	Demand - Interval (minutes)					x			x		x
555.METER.ELECTRIC.PF-TOT	Power Factor - Total (%)					x			x		x
555.METER.ELECTRIC.PF-A	Power Factor - Phase A (%)					x			x		x
555.METER.ELECTRIC.PF-B	Power Factor - Phase B (%)					x			x		x
555.METER.ELECTRIC.PF-C	Power Factor - Phase C (%)					x			x		x
555.METER.ELECTRIC.VOLTS-HD-A	Voltage - Harmonic Distortion - Phase A (%)					x			x		x
555.METER.ELECTRIC.VOLTS-HD-B	Voltage - Harmonic Distortion - Phase B (%)					x			x		x
555.METER.ELECTRIC.VOLTS-HD-C	Voltage - Harmonic Distortion - Phase C (%)					x			x		x
555.METER.ELECTRIC.AMPS-HD-A	Current - Harmonic Distortion - Phase A (%)					x			x		x
555.METER.ELECTRIC.AMPS-HD-B	Current - Harmonic Distortion - Phase B (%)					x			x		x
555.METER.ELECTRIC.AMPS-HD-C	Current - Harmonic Distortion - Phase C (%)					x			x		x
555.METER.ELECTRIC.FREQ	Frequency (Hz)					x			x		x
555.METER.ELECTRIC.CONSUMPTION	Consumption (kWh)					x			x		x
555.METER.ELECTRIC.VOLT-MODE	Voltage Mode					x			x		x
555.METER.ELECTRIC.CT-RATIO-PRIMARY	CT Ratio - Primary					x			x		x
555.METERING.MAIN-WATER-METER	Main Water Meter Totalization Point			x					x	x	x
555.METERING.MAIN-GAS-METER	Main Natural Gas Meter Totalization Point			x					x	x	x
<b>Domestic Hot Water System</b>											
555.DHW.DHWS-T-1	Domestic Hot Water Supply Temp (60°C System)	x							x	x	x
555.DHW.THWS-T-2	Tempered Hot Water Supply Temp (43°C System)	x							x	x	x
555.DHW.DHWH-S	DHW Heater Run Status (Multiple Units)			x					x		x
555.DHW.RP1-S	DHW Recirc Pump #1 Status			x					x	x	x
555.DHW.DHWH-EN	DHW Heater Enable Command (Multiple Units)				x				x		x
555.DHW.RP1-C	DHW Recirc Pump #1 Command				x				x		x
555.DHW.OCC-MODE	Occupancy Mode Point						x	x	x		x

Point Name	Point Description	Analog Inputs	Analog Outputs	Binary Inputs	Binary Outputs	Analog Variables	Binary Variables	Schedule/Calendar	Trend	Alarm	Show On Graphic
<b>Radiant Panels/ Perimeter Radiation (Multiple Rooms Refer to Plans)</b>											
555.RADS.RMvvv.ZN-T	Zone Temperature	x							x	x	x
555.RADS.RMvvv.RAD-HTG-O	Perimeter Radiant Heating Valve Output		x						x		x
555.RADS.RMvvv.HTG-SP	Zone Heating Setpoint					x					x
555.RADS.RMvvv.UNOCC-HTG-SP	Unoccupied Mode Zone Heating Setpoint					x					x
555.RADS.RMvvv.OCC-MODE	Occupancy Mode Point						x	x	x		x
<b>VAV Box with Reheat (Multiple Rooms Refer to Plans)</b>											
555.VAV.RMvvv.ZN-T	Zone Temperature (Share with Perimeter Rad/Radiant Panel where Applicable)	x							x	x	x
555.VAV.RMvvv.VAVD-O	VVT Box Damper Output		x						x		x
555.VAV.RMvvv.RH-HTG-O	Reheat Valve Output		x						x		x
555.VAV.RMvvv.HTG-SP	Zone Heating Setpoint					x					x
555.VAV.RMvvv.CLG-SP	Zone Cooling Setpoint					x					x
555.VAV.RMvvv.UNOCC-HTG-SP	Unoccupied Mode Zone Heating Setpoint					x					x
555.VAV.RMvvv.UNOCC-CLG-SP	Unoccupied Mode Zone Cooling Setpoint					x					x
555.VAV.RMvvv.OCC-MODE	Occupancy Mode Point						x	x	x		x
555.VAV.RMvvv.DA-T	VVT Discharge Air Temperature	x							x	x	x
555.VAV.RMvvv.DA-F	VVT Discharge Air Flow	x							x	x	x
<b>Mech Room Motorized Damper</b>											
555.MD.RMvvv.ZN-T	Zone Temperature	x							x	x	x
555.MD.RMvvv.VAVD-O	Bypass Box Damper Output		x						x		x
555.MD.RMvvv.HTG-SP	Zone Heating Setpoint					x					x
555.MD.RMvvv.CLG-SP	Zone Cooling Setpoint					x					x
555.MD.RMvvv.UNOCC-HTG-SP	Unoccupied Mode Zone Heating Setpoint					x					x
555.MD.RMvvv.UNOCC-CLG-SP	Unoccupied Mode Zone Cooling Setpoint					x					x
555.MD.RMvvv.OCC-MODE	Occupancy Mode Point						x	x	x		x
<b>Lighting Control</b>											
555.LIGHTS.LTG1-EN	Outdoor Pole Lights Enable Command				x			x	x		x
555.LIGHTS.LTG1-S	Outdoor Pole Lights Status			x					x	x	x
555.LIGHTS.LTG2-EN	Outdoor Building Lights Enable Command				x			x	x		x
555.LIGHTS.LTG2-S	Outdoor Building Lights Status			x					x	x	x
555.LIGHTS.PHOTOCELL-S	Outdoor Photocell Status (2)			x					x	x	x
555.Power.RMvvv.PWR-C	Power Shut-off Command (1 Total)				x			x	x		x
<b>Security/Fire Alarm Panel</b>											
555.SECURITY.LTG1-EN	Security Status Interior Lighting Command				x			x	x		x
555.SECURITY.SP-S	Security Panel Status			x							x
555.FIRE.FIREALM-S	Fire Alarm Status			x					x	x	x
555.SECURITY.SPARE-ALM-1	BAS-To-Security Panel - Spare Wire 1			x							x
555.SECURITY.SPARE-ALM-2	BAS-To-Security Panel - Spare Wire 2			x							x
<b>Forced Flow Heaters/Unit Heater (Multiple Units Refer to Plans)</b>											
555.FFH.RMvvv.FFH-EN	Forced Flow Heater Enable Command				x				x		x
555.FFH.RMvvv.ZN-T	Zone Temperature	x							x	x	x
555.FFH.RMvvv.HTG-SP	Zone Heating Setpoint					x					x
555.FFH.RMvvv.UNOCC-HTG-SP	Unoccupied Mode Zone Heating Setpoint					x					x

Point Name	Point Description	Analog Inputs	Analog Outputs	Binary Inputs	Binary Outputs	Analog Variables	Binary Variables	Schedule/Calendar	Trend	Alarm	Show On Graphic
<b>Duct Mounted Reheat Coil (Multiple Rooms Refer to Plans)</b>											
555.RH.RMvvv.ZN-T	Zone Temperature (Share with Perimeter Rad/Radiant Panel where Applicable)	x							x	x	x
555.RH.RMvvv.RH-HTG-O	Reheat Valve Output		x						x		x
555.RH.RMvvv.HTG-SP	Zone Heating Setpoint					x					x
555.RH.RMvvv.UNOCC-HTG-SP	Unoccupied Mode Zone Heating Setpoint					x					x
555.RH.RMvvv.OCC-MODE	Occupancy Mode Point						x	x	x		x
555.RH.RMvvv.DA-T	Discharge Air Temperature	x							x	x	x
<b>Electric Heat Control (Multiple Rooms Refer to Plans)</b>											
555.EH.RMvvv.ZN-T	Zone Temperature (Share with EF)	x							x	x	x
555.EH.RMvvv.RH-HTG-O	Electric Heat Command		x						x		x
555.EH.RMvvv.HTG-SP	Zone Heating Setpoint					x					x
555.EH.RMvvv.UNOCC-HTG-SP	Unoccupied Mode Zone Heating Setpoint					x					x
555.EH.RMvvv.OCC-MODE	Occupancy Mode Point						x	x	x		x



## **Division 26 Common Requirements for Electrical**

26 00 11	Electrical Specification Index
	<b>Common Contract Requirements for Electrical</b>
26 01 15	Electrical Allowances – Division 1
26 01 16	Electrical Contract General Requirements
26 01 17	Demolition and Renovation
26 01 19	Commissioning of Electrical Systems
26 01 20	Integrated Testing of Fire Protection and Life Safety Systems
	<b>Common Work Results for Electrical</b>
26 05 19	Wires and Cables
26 05 20	Junction and Pull Boxes
26 05 21	Outlet Boxes, Conduit Boxes and Fittings
26 05 22	Wire and Box Connectors – 0 –1000 V
26 05 26	Grounding Secondary
26 05 27	Seismic Restraint for Electrical Systems
26 05 33	Conduits, Conduit Fastenings and Conduit Fittings
26 05 43	Installation of Cables in Trenches and Ducts
26 05 73	Short Circuit/Coordination Study
26 05 75	Auxiliary Systems
	<b>Low-Voltage Transformers</b>
26 22 13	Dry Type Transformers
	<b>Switchboard and Panelboards</b>
26 24 16	Panelboards
26 24 17	Moulded Case Circuit Breakers
	<b>Low-Voltage Distribution Equipment</b>
26 27 26	Wiring Devices
	<b>Low-Voltage Circuit Protective Devices</b>
26 28 13	Fuses – Low Voltage
26 28 16	Disconnect Switches
	<b>Low-Voltage Controllers</b>
26 29 13	Starters and Contactors
	<b>Electrical and Cathodic Protection</b>
26 43 13	Surge Protective Devices
	<b>Lighting</b>
26 51 13	Lighting Equipment
26 51 16	Digital Occupancy & Daylight Control Systems

## **Division 27 Communications**

	<b>Voice Communications Switching and Routing Equipment</b>
27 31 40.1	Telecommunication Network Installations
	<b>Audio – Video Systems</b>
27 41 16.1	Public Address System

## **Division 28    Electronic Safety and Security**

### **Intrusion Detection**

28 16 16      Security System

### **Fire Detection and Alarm**

28 31 25      Fire Alarm System (Addressable)

**END OF SECTION**

**Part 1            General**

**1.1            GENERAL INSTRUCTIONS**

- .1    Comply with the General Conditions, Supplementary Conditions, and all of Division 1.
- .2    Allowances are indicated in Division 1 for this project. Refer to Division 1 to obtain allowance values.

**1.2            CASH ALLOWANCE (HST EXCLUDED)**

- .1    Refer to current CCDC requirement and Division 1 for CASH ALLOWANCES.
- .2    HST (Harmonized Sales Tax) is not included in cash allowance(s).
- .3    Allowances are stated in Division 1 of this project specification. It is the responsibility of the Electrical Contractor to review all allowances. If no allowances are identified, the Electrical Contract Price shall include all costs associated for the full scope of work and materials related to Electrical Contract Documents prepared by the Consultant.
- .4    Allowances shall be expended as the Owner directs through the Consultant. The Consultant will direct the Contractor(s) to **purchase** and perform work for which payment is made from an allowance.
- .5    Unless otherwise noted, the stated allowances for equipment purchase include initial distributor mark-up for the material components. The installation of these allowance items, along with required power connections, device boxes, conduit, controls, cabling, cable terminations with testing, making operable, and warranty must be included in the electrical tender price. Therefore, the Contractor shall include any overhead and profit on the allowance value in their tendered price and not from within the allowance value.
- .6    Where the actual cost of the Work under any cash allowance is less than the amount of the allowance, the Owner shall be credited for the unexpended portion of the cash allowance, but not for the Contractor's overhead and profit on such amount.
- .7    Where the allowance is insufficient to cover the actual cost the difference in value will be addressed as a change order.
- .8    The value of the work performed under a cash allowance is eligible to be included in progress payments.

#### **1.4 EXPENDITURE OF CASH ALLOWANCES**

- .1 Owner, through Consultant, will provide Contractor with documentation required to permit pricing of a cash allowance item.
- .2 Owner, through Consultant, may request Contractor to identify potential Suppliers or Subcontractors, as applicable, and to obtain at least three competitive prices for each cash allowance item.
- .3 Owner, through Consultant, may request the Contractor to disclose originals of all bids, quotations, and other price related information received from potential Suppliers or Subcontractors.
- .4 Owner, through Consultant, will determine by whom and for what amount each cash allowance item will be performed. Obtain Owner's prior written approval in the form of a Change Order before entering into a subcontract, amending an existing subcontract, or performing own forces work included in a cash allowance. Upon issuance of the Change Order, the Contractor's responsibilities for a cash allowance item shall be the same as for other work of the Contract.
- .5 Refer to CCDC 2 – 2020, GC4.1.4. Where the actual cost of the Work under any cash allowance exceeds the amount of the allowance, and unexpended amounts from other cash allowance shall be reallocated, at the Consultant's direction, to cover the shortfall, and, in that case, there shall be no additional amount added to the Contract Price for overhead and project.
- .6 Only where the actual cost of the Work under all cash allowances exceeds the total amount of all cash allowances shall the Contractor be compensated for the excess incurred and substantiated, plus an amount for overhead and profit on the excess only, as set out in the Contract Documents.
- .7 Where the actual cost of all the Work under the cash allowances are less than the amount of the allowances, the Owner shall be credited for the unexpended portion of the cash allowances, but not for the Contractor's overhead and profit on such amount.

#### **1.5 CASH ALLOWANCE CONTRACT REQUIREMENTS**

- .1 The Contractor accepts to provide all contract requirements for the products supplied in the allowances, this includes providing supervision to include the product into the contract, shop drawing submission, coordinating installation, accepting warranty, accepting instruction to the Owner, providing as-builts, including product literature in maintenance manuals, etc.
- .2 All this work must be included in the Contractor's tender price.

**Part 2 Not Used**

**Part 3 Not Used**

**END OF SECTION**

**Part 1            General**

**1.1            GENERAL**

- .1        This Section covers items common to Electrical Division 26, as well as Division 27 and Division 28.**
- .2        This section supplements requirements of Division 1.
- .3        Furnish labour, materials, and equipment necessary for completion of work as described in contract documents.

**1.2            INTENT**

- .1        Mention herein or indication on Drawings of articles, materials, operations, or methods requires: supply of each item mentioned or indicated, of quality, or subject to qualifications noted; installation according to conditions stated: and, performance of each operation prescribed with furnishing of necessary labour, equipment, and incidentals for electrical work.
- .2        Where used, words “Section” and “Division” shall also include other Subcontractors engaged on site to perform work to make building and site complete in all respects.
- .3        Where used, word “supply” shall mean furnishing to site in location required or directed complete with accessory parts.
- .4        Where used, word “install” shall mean secured in place and connected up for operation as noted or directed.
- .5        Where used, word “provide” shall mean supply and install as each is described above.

**1.3            ELECTRICAL SAFETY AUTHORITY**

- .1        The contractor is to determine general inspection fees with Electrical Safety Authority and include as part of tender.

**1.4            DRAWINGS**

- .1        Electrical Drawings do not show structural and related details. Take information involving accurate measurement of building from building drawings, or at building. Make, without additional charge, any necessary changes or additions to runs of conduits and ducts to accommodate structural conditions. Location of conduits and other equipment may be altered by the consultant without extra charge provided change is made before installation and does not necessitate major additional material.
- .2        As work progresses and before installing fixtures and other fittings and equipment which may interfere with interior treatment and use of building, provide detail drawings or obtain directions for exact location of such equipment and fitments.

- .3 Electrical drawings are diagrammatic. Where required work is not shown or only shown diagrammatically, install same at maximum height in space to conserve head room (minimum 2200 mm (88") clear) and interfere as little as possible with free use of space through which they can pass. Conceal wiring, conduits and ducts in furred spaces, ceilings and walls unless specifically shown otherwise. Install work close to structure so furring will be small as practical.
- .4 Before commencing work, check and verify all sizes, locations, grades, elevations, levels and dimensions to ensure proper and correct installation. Verify existing/municipal services.
- .5 Locate all electrical equipment in such a manner as to facilitate easy and safe access to and maintenance and replacement of any part.
- .6 In every place where there is indicated space reserved for future or other equipment, leave such space clear, and install services so that necessary installation and connections can be made for any such apparatus. Obtain instructions whenever necessary for this purpose.
- .7 Relocate equipment and/or material installed but not coordinated with work of other Sections as directed, without extra charge.
- .8 Where drawings are done in metric and product not available in metric, the corresponding imperial trade size shall be utilized.

#### **1.5 INTERFERENCE AND COORDINATION DRAWINGS**

- .1 Prepare interference and equipment placing drawings to ensure that all components will be properly accommodated within the constructed spaces provided.
- .2 Prepare drawings to indicate coordination and methods of installation of a system with other systems where their relationship is critical. Ensure that all details of equipment apparatus, and connections are coordinated.
- .3 Ensure that clearances required by jurisdictional authorities and clearances for proper maintenance are indicated on drawings.
- .4 Upon consultant's request submit copies of interference drawings to the consultant.
- .5 Provide CAD drawings (minimum file version AutoCAD 2013) in addition to hard copies.

#### **1.6 QUALITY ASSURANCE**

- .1 The installations of the division must conform to the latest edition of the Electrical Safety Code as well as its supplemental bulletins and instructions. Provide materials and labour necessary to comply with rules, regulations, and ordinances.
- .2 Complete underground systems in accordance with CSA C22.3 No. 7-94 except where specified otherwise.
- .3 Abbreviations for electrical terms: to CSA Z85-1983.
- .4 In case of differences between building codes, provincial laws, local ordinances, utility company regulations, and Contract Documents, the most stringent shall govern. Promptly notify consultant in writing of such differences.

## **1.7 ALTERNATES AND SUBSTITUTIONS**

- .1 Throughout these sections are lists of “Alternate Equipment” manufacturers acceptable to consultant if their product meets characteristics of specified described equipment.
- .2 When two or more suppliers/manufacturers are named in the Bid Documents, only one supplier/manufacturer of the products named will be acceptable; however, it is the responsibility of this Division to ensure “Alternate Equipment” fits space allocated and gives performance specified. If an “Alternate Equipment” unit is proposed and does not fit space allotted nor equal specified product in consultant’s opinion, supply of specified described equipment will be required without change in Contract amount. Only manufacturers listed will be accepted for their product listing. All other manufacturers shall be quoted as substitution stating conditions and credit amount.
- .3 If item of material specified is unobtainable submit questions during tender period.

## **1.8 EXAMINATION**

- .1 Site Reviews
  - .1 Examine premises to understand conditions, which may affect performance of work of this Division before submitting proposals for this work.
  - .2 No subsequent allowance for time or money will be considered for any consequence related to failure to examine site conditions.
- .2 Drawings:
  - .1 Electrical Drawings show general arrangement of fixtures, power devices, equipment, etc. Follow as closely as actual building construction and work of other trades will permit.
  - .2 Consider Architectural, Mechanical, and Structural Drawings part of this work insofar as these drawings furnish information relating to design and construction of building. These drawings take precedence over Electrical Drawings.
  - .3 Because of small scale of Drawings, it is not possible to indicate all offsets, fittings, and accessories, which may be required. Investigate structural and finish conditions affecting this work and arrange work accordingly, providing such fittings, valves, and accessories required to meet conditions.
- .3 Ensure that items to be furnished fit space available. Make necessary field measurements to ascertain space requirements including those for connections and furnish and install equipment of size and shape so final installation shall suit true intent and meaning of Contract Documents. If approval is received by Addendum or Change Order to use other than originally specified items, be responsible for specified capacities and for ensuring that items to be furnished will fit space available.

## **1.9 SEQUENCING AND SCHEDULING**

- .1 It is understood that while Drawings are to be followed as closely as circumstances permit, this Division will be held responsible for installation of systems according to the true intent and meaning of Contract Documents. Anything not clear or in conflict will be explained by making application to consultant. Should conditions arise where certain changes would be advisable, secure consultant's approval of these changes before proceeding with work.
- .2 Coordinate work of various trades in installing interrelated work. Before installation of electrical items, make proper provision to avoid interferences in a manner approved by consultant. Changes required in work specified in these sections caused by neglect to do so shall be made at no cost to owner.
- .3 Arrange fixtures, conduit, ducts, and equipment to permit ready access to junction boxes, starters, motors, control components, and to clear openings of doors and access panels.
- .4 Furnish and install inserts and supports required by these sections unless otherwise noted. Furnish sleeves, inserts, supports, and equipment that are an integral part of other Divisions of the Work to Sections involved in sufficient time to be built into construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne by the electrical trade.
- .5 Adjust locations of ducts, conduits, equipment, fixtures, etc., to accommodate work from interferences anticipated and encountered. Determine exact route and location of each conduit and duct prior to installation.
  - .1 Make offsets, transitions, and changes in direction of ducts, and electrical raceways as required to maintain proper head room and pitch of sloping lines whether or not indicated on Drawings.
  - .2 Supply and install pull boxes, etc., as required to affect these offsets, transitions, and changes in direction.

## **1.10 REQUEST FOR INFORMATION (RFI) PROCEDURES**

- .1 RFIs shall be submitted to the consultant minimum two (2) weeks prior to answer being required. Failure to submit and RFI in a timely manner will forfeit delay claims and schedule extension requests by the contractor.
- .2 All RFIs will be submitted with the following information:
  - .1 RFI number
  - .2 Name of project
  - .3 Date of initiation
  - .4 Date response required by (minimum two (2) weeks)
  - .5 Subject
  - .6 Submitter's name
  - .7 Drawing/specification reference



- .8 Photograph of the issue (if applicable)
- .9 Description of the issue
- .10 Contractor's proposed resolution

**1.11 DRAW BREAKDOWN**

- .1 This contractor **MUST** submit a breakdown of the tender price into classifications to the satisfaction of the consultant, with the aggregate of the breakdown totaling the total contract amount. **Each item must be broken out into material and labour costs.** Progress claims, when submitted are to be itemized against each item of the draw breakdown. This shall be done in table form showing contract amount, amount this draw, total to date, % complete and balance.
- .2 Breakdown shall be as follows:
  - .1 Permits and fees
  - .2 Mobilization (maximum 1%)
  - .3 Demolition
  - .4 Panelboards and miscellaneous distribution equipment
  - .5 Feeder conduits
  - .6 Branch conduits
  - .7 Feeder cables
  - .8 Branch wiring
  - .9 Lighting fixtures (interior)
  - .10 Emergency lighting
  - .11 Exterior lighting
  - .12 Fire alarm system
  - .13 Public address system rough-ins
  - .14 Surge protective devices
  - .15 Security system rough-ins
  - .16 Voice/Data system rough-ins
  - .17 Starters, contactors and control devices
  - .18 Wiring for mechanical equipment
  - .19 Wiring for owner's equipment
  - .20 **Integrated Life Safety System Testing**
  - .21 Commissioning (minimum 3%)

- .3 The breakdown must be approved by the consultant prior to submission of the first draw.
- .4 Breakdowns not complying to the above will not be approved.
- .5 Breakdown must indicate total contract amount.
- .6 **Mobilization amount may only be drawn when all required shop drawings have been reviewed by the consultant.**

#### 1.12 SHOP DRAWINGS AND PRODUCT DATA

- .1 General
  - .1 Furnish complete catalog data for manufactured items of equipment to be used in the work to consultant for review within 14 days after award of Contract.
  - .2 Upon receipt of reviewed shop drawing, product is to be ordered immediately.
  - .3 Provide a complete list of shop drawings to be submitted prior to first submission.
  - .4 Before submitting to the consultant, review all shop drawings to verify that the products illustrated therein conform to the Contract Documents. By this review, the contractor agrees that it has determined and verified all field dimensions, field construction criteria, materials, catalogue numbers, and similar data and that it has checked and coordinated each shop drawing with the requirements of the work and of the Contract Documents. The contractor's review of each shop drawings shall be indicated by stamp, date and signature of a qualified and responsible person possessing by the appropriate authorization.
  - .5 If material or equipment is not as specified or submittal is not complete, it will be rejected by consultant.
  - .6 Additional shop drawings required by the contractor for maintenance manuals, site copies etc., shall be photocopies of the "reviewed" shop drawings. All costs to provide additional copies of shop drawings shall be borne by the contractor.
  - .7 **Submit all shop drawings for the project as a package. Partial submittals will not be accepted.**
  - .8 Catalog data or shop drawings for equipment, which are noted as being reviewed by consultant or his engineer shall not supersede Contract Documents.
  - .9 Review comments of consultant shall not relieve this Division from responsibility for deviations from Contract Documents unless consultant's attention has been called to such deviations in writing at time of submission, nor shall they relieve this Division from responsibility for errors in items submitted.
  - .10 Check work described by catalog data with Contract Documents for deviations and errors.
  - .11 Shop drawings and product data shall show:
    - .1 Mounting arrangements.
    - .2 Operating and maintenance clearances. e.g. access door swing spaces.

- 
- .12 Shop drawings and product data shall be accompanied by:
    - .1 Detailed drawings of bases, supports, and anchor bolts.
    - .2 Manufacturer test data where requested.
    - .3 Manufacturer to certify as to current model production.
    - .4 Certification of compliance to applicable codes.
  - .13 State sizes, capacities, brand names, motor HP, accessories, materials, gauges, dimensions, and other pertinent information. List on catalog covers page numbers of submitted items. Underline applicable data.
  - .14 **If a shop drawing is returned “reviewed as noted” this contractor must provide written indication that the comments have been complied with.**
  - .15 A partial list of shop drawings includes:
    - .1 Panelboards and transformers
    - .2 Fire alarm system
    - .3 Luminaires and drivers
    - .4 Emergency battery units, exit signs, and fixtures
    - .5 Starters, contactors and control devices
    - .6 Firestopping materials
    - .7 Hand dryers
    - .8 Wiring devices
    - .9 Clocks
    - .10 Cable management system
    - .11 Lighting controls
    - .12 Disconnect switches and fuses
    - .13 Surge protection devices
    - .14 Destratification fans and associated controls
    - .15 Roof cone
    - .16 Coordination study
    - .17 Integrated Life Safety System Testing Plan (ITP)
  - .2 Submissions shall be submitted electronically as per the following directions:
    - .1 Electronic Submissions:
      - .1 Electronically submitted shop drawings shall be prepared as follows:
        - .1 Use latest software to generate PDF files of submission sheets.
        - .2 Scanned legible PDF sheets are acceptable. Image files are not acceptable.
        - .3 PDF format shall be of sufficient resolution to clearly show the finest detail.
        - .4 PDF page size shall be standardized for printing to letter size (8.5" x 11"), portrait with no additional formatting required by the consultant. Submissions requiring larger detail sheets shall not exceed 11" x 17".

- .5 Submissions shall contain multiple files according to section names as they appear in Specification.
- .6 File names shall include consultant project number and description of shop drawing section submitted.
- .7 Each submission shall contain an index sheet listing the products submitted, indexed in the same order as they appear in the Specification. Include associated PDF file name for each section.
- .8 On the shop drawing use an “electronic mark” to indicate what is being provided.
- .9 **Each file shall bear an electronic representation of the “company stamp” of the contractor. If not stamped the file submission will not be reviewed.**
- .2 Email submissions shall include subject line to clearly identify the consultants’ project number and the description of the shop drawings submitted.
- .3 Electronic attachments via email shall not exceed 10MB. For submissions larger than 10MB, multiple email messages shall be used. Denote related email messages by indicating “1 of 2” and “2 of 2” in email subject line for the case of two messages.
- .4 Electronic attachments via web links (URL) shall directly reference PDF files. Provide necessary access credentials within link or as username/password clearly identified within body of email message.
- .5 On site provide one copy of the “reviewed” shop drawings in a binder as noted above.
- .6 Contractor to print copies of “reviewed” shop drawings and compile into maintenance manuals in accordance with requirements detailed in this section.

#### **1.13 CARE, OPERATION AND START-UP**

- .1 Instruct consultant and operating personnel in the operation, care and maintenance of equipment.
- .2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components.
- .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 all aspects of its care and operation.

#### **1.14 VOLTAGE RATINGS**

- .1 Operating voltages: to CAN3-C235-83.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

---

**1.15 PERMITS, FEES AND INSPECTION**

- .1 The contractor is required to include in his tender all required inspection costs by the Electrical Safety Authority. Permit application is the responsibility of the contractor.
- .2 Reproduce drawings and specifications required by Electrical Safety Authority at no cost.
- .3 Notify consultant of changes required by Electrical Safety Authority prior to making changes.
- .4 Furnish Certificates of Acceptance to consultant from Electrical Safety Authority and other authorities having jurisdiction upon completion of work.
- .5 This contractor must furnish any certificates required to indicate that the work completed conforms with laws and regulations of authorities having jurisdiction.

**1.16 ADDITIONAL INSTALLED EQUIPMENT**

- .1 The electrical contractor is to review all specification sections forming part of the electrical bid documents and include additional equipment or components, as well as all associated installation costs and testing costs as noted, in the electrical bid price.

**1.17 MATERIALS AND EQUIPMENT**

- .1 Equipment and material to be CSA certified. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Electrical Safety Authority.
- .2 Factory assemble control panels and component assemblies.

**1.18 ELECTRIC MOTORS, EQUIPMENT, AND CONTROLS**

- .1 Supplier and installer responsibility is indicated in the Equipment Wiring Schedule on electrical drawings.
- .2 Control wiring and conduit is specified in the Electrical specifications except for conduit, wiring and connections below 50 V, which are related to control systems specified in the Mechanical specifications.

**1.19 FINISHES**

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
  - .1 Paint outdoor electrical equipment "equipment green" finish.
  - .2 Paint indoor switchgear and distribution enclosures light grey.
- .2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .3 Clean and prime exposed non-galvanized hangers, racks, fastenings, and conduits etc. to prevent rusting.

## **1.20 EQUIPMENT IDENTIFICATION**

- .1 Identify electrical equipment with nameplates as follows:
- .2 Nameplates:
  - .1 Lamicoid 3 mm (1/8") thick plastic engraving sheet, black face, white core, mechanically attached with self tapping screws.

### **NAMEPLATE SIZES**

Size 1	9 mm x 50 mm (3/8" x 2")	1 line	3 mm (1/8") high letters
Size 2	12 mm x 70 mm (1/2" x 2 1/2")	1 line	5 mm (3/16") high letters
Size 3	12 mm x 70 mm (1/2" x 2 1/2")	2 lines	3 mm (1/8") high letters
Size 4	20 mm x 90 mm (3/4" x 3 1/2")	1 line	9 mm (3/8") high letters
Size 5	20 mm x 90 mm (3/4" x 3 1/2")	2 lines	5 mm (3/16") high letters
Size 6	25 mm x 100 mm (1" x 4")	1 line	12 mm (1/2") high letters
Size 7	25 mm x 100 mm (1" x 4")	2 lines	6 mm (1/4") high letters

- .3 Wording on nameplates labels to be approved by consultant prior to manufacture.
- .4 Allow for average of twenty-five (25) letters per nameplate.
- .5 Identification to be English.
- .6 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .7 Nameplates for disconnects, starters and contactors must indicate equipment being controlled and voltage.
- .8 Nameplates for transformers must indicate transformer label as indicated and capacity, primary, and secondary voltages.

## **1.21 WIRING IDENTIFICATION**

- .1 Identify wiring with permanent indelible identifying markings, either numbered or 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 code: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.

## **1.22 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 (45') intervals.

- .3 Colour bands must be 25 mm (1") wide.

	<u>Prime</u>
up to 208 V	yellow
209 to 600 V	white
Voice system	green
Data System	orange
Security	brown
Public address	black
Fire alarm	red
Emergency lighting	pink

- .4 This contractor must paint all system junction boxes and covers in conformance with the above schedule.

### **1.23 PROTECTION OF OPENINGS**

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

### **1.24 WIRING TERMINATIONS**

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

### **1.25 MANUFACTURERS AND CSA LABELS**

- .1 All labels must be visible and legible after equipment is installed.

### **1.26 WARNING SIGNS**

- .1 To meet requirements of Electrical Safety Authority and consultant.  
.2 Provide porcelain enamel signs, with a minimum size of 175 mm x 250 mm (7" x 10").

### **1.27 LOCATION OF OUTLETS**

- .1 Do not install outlets back-to-back in wall; allow minimum 150 mm (6") horizontal clearance between boxes.  
.2 Owner may change location of outlets at no extra cost or credit, providing distance does not exceed 3 m (10'), and information is given before installation.  
.3 Locate light switches on latch side of doors. Locate disconnect devices in mechanical and elevator machine rooms on latch side of door.

### **1.28 MOUNTING HEIGHTS**

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise. Coordinate with block coursing (if applicable).  
.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: 1100 mm (43.3").

.2 Wall receptacles:

.1 General: 400 mm (16").

.2 Above top of continuous baseboard heater: 200 mm (8").

.3 Above top of counters or counter splash backs: 100 mm (4").

.4 In mechanical rooms: 1200 mm (48").

.3 Panelboards: as required by Code or 1400 mm (56").

.4 Voice/Data outlets: At height of adjacent outlet or at 400 mm (16").

.5 Fire alarm stations: 1200 mm (3'-11").

.6 Fire alarm visual and signal devices: 2250 mm (88 ½").

.7 Thermostat: 1200 mm (3'-11").

.8 Clocks: 2100 mm (84").

.9 Emergency call switches and/or pushbuttons: 900 mm (36").

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

#### **1.30 CONDUIT AND CABLE INSTALLATION**

- .1 Install conduit and sleeves prior to pouring of concrete. Sleeves through concrete shall be schedule 40 steel pipe, sized for free passage of conduit, and protruding 50 mm (2") beyond either side.
- .2 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.

#### **1.31 FIELD QUALITY CONTROL**

- .1 Conduct and pay for following tests:
  - .1 Power 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 system, communications, security.
- .2 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.
- .3 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.
- .4 Carry out tests in presence of consultant.
- .5 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .6 Submit test results for consultant's review.

#### **1.32 EQUIPMENT NAMEPLATE DATA**

- .1 Refer to the Equipment Wiring Schedule, Distribution Diagram(s) and Panel Schedules for information regarding the designed electrical connections for all equipment to be connected to the electrical distribution system.
- .2 Refer to the shop drawing submissions of all project divisions and coordinate with all trades and equipment manufacturers throughout the construction period for equipment connection requirements.
- .3 This electrical trade shall be responsible to coordinate any discrepancies on equipment minimum circuit ampacity, maximum overcurrent protection, voltage and phase, between the equipment manufacturer published literature, the equipment shop drawing submission, the project design drawings equipment wiring schedule, and the nameplate data on the equipment. The contractors installing and connecting all equipment shall be responsible for the coordination of this data through the construction period.
- .4 Equipment shall not be connected where the specified maximum overcurrent protection and minimum circuit ampacity values do not meet the requirements of the equipment nameplate data on site.
- .5 Electrical distribution equipment shop drawings shall not be submitted prior to approval of equipment to be connected including, but not limited to, mechanical units, pumps, elevators, etc. Electrical distribution equipment shall not be released into production until all connected equipment requirements are confirmed and included in approved shop drawings.
- .6 Where nameplate data of equipment on site varies from that data listed in the approved equipment shop drawings, the consultant shall be notified in writing, and the equipment shall not be connected until the equipment connection details are confirmed. The final installation must meet the nameplate data of the equipment on site.

- .7 No subsequent allowance for time or money for changes to breakers, wiring and conduit, or equipment sizes will be considered for any consequence related to failure by the electrical trade to coordinate final equipment connection requirements with nameplate data and electrical distribution equipment shop drawings.

### **1.33 COORDINATION OF PROTECTIVE DEVICES**

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings as indicated on drawings or as determined from coordination study.
- .2 Electrical connections to all equipment requiring connection to the electrical distribution system as part of this electrical tender have been specified according to the anticipated equipment manufacturer electrical requirements and the applicable sections of the OESC. This contractor must coordinate electrical connections to all equipment specified to be connected as part of this electrical tender.
- .3 Prior to submitting electrical distribution shop drawings to the consultant, review all shop drawings for all equipment specified for connection to the electrical distribution system to verify that the product electrical connection requirements listed by the manufacturer conform to the equipment electrical connections specified on the electrical design drawings and specifications. Make necessary revisions to breaker ratings associated with the review of all product shop drawings and identify such changes as part of the electrical distribution equipment shop drawing submission.
- .4 Prior to making final equipment connections, this electrical contractor shall examine equipment nameplates at the project site to confirm voltage and phase requirements, minimum circuit ampacity and maximum overcurrent protection values, and bring to the attention of the consultant in writing any connection requirements which may vary from the designed connections or approved electrical distribution shop drawings. No subsequent allowance for time or money for changes to breaker or wire and conduit sizes will be considered for any consequence related to failure to examine site conditions.

### **1.34 GUARANTEE AND WARRANTY**

- .1 At ready for takeover of this project this Contractor must provide a written guarantee indicating that any defects, not due to ordinary wear and tear or improper use which occur within the first year from the date of ready for takeover will be corrected at the contractors expense.
- .2 **If the electrical sub-contractor's office is 50 kilometers (30 miles) or more from the project site, the sub-contractor is to provide a service/warranty work agreement for warranty period with a local electrical sub-contractor approved by consultant. Include copy of service/warranty agreement in warranty section of operation and maintenance manual.**
- .3 Warranty period shall start from date of ready for takeover completion.
- .4 Refer to individual specification sections for information on any special manufacturer's equipment warranties.

---

**1.35 SYSTEM START UP**

- .1 Provide consultant with written notice verifying all equipment operation and installation is complete prior to scheduled start-up period.
- .2 Start up shall be in presence of the following: owner or representative, contractor, and manufacturer's representative. Each person shall witness and sign off each piece of equipment. Consultant's attendance will be determined by consultant.
- .3 Arrange with all parties and provide 72 hours notice for start up procedure.
- .4 Simulate system start up and shut down and verify operation of each piece of equipment.
- .5 These tests are to demonstrate that the systems and equipment installed are operational as specified.
- .6 The contractor must describe during the start up session the required maintenance for each piece of equipment according to the manufacturer.
- .7 The contractor must provide all necessary tools (including a digital multimeter) to successfully complete the start up procedure.

**1.36 OPERATION AND MAINTENANCE MANUAL**

- .1 Provide operation and maintenance data for incorporation into manual as specified in other Sections of this Division.
- .2 Operation and maintenance manual to be approved by, and final copies deposited with, consultant before final inspection.
  - .1 Submit one copy of Operation and Maintenance Manual to consultant for approval. Submission of individual data will not be accepted unless so directed by consultant. Submission can be done electronically in pdf format or as a hardcopy.
    - .1 Electronic submission/pdf file is required to be bookmarked. Any submission received without bookmarking will be immediately returned as unacceptable.
    - .2 Hardcopy submission shall be in a three-ring binder (minimum 50 mm (2") ring) and labelled as 'Operation and Maintenance Manual' with project name and location. Dividers are to be used for binder organization.
  - .2 Make changes as required and re-submit as directed by consultant.
- .3 Each manual must include (in "tabbed" sections) the following:
  - .1 Index
  - .2 List of General, Mechanical, Electrical Contractors and all associated sub-contractor names, addresses and contact numbers.
  - .3 List of suppliers and equipment wholesalers local to the project.
  - .4 Letter of contractor's warranty and guarantee for all parts, equipment and workmanship.
  - .5 List of manufacturers, spare parts list and source.

- .6 Copy of typewritten schedules for all new and renovated panels.
- .7 Copy of all substantial performance final certificates.
- .8 Copy of electrical shop drawings which have been stamped and reviewed by consultant.
- .9 Electrical As-built drawings including contractor company's as built stamp.
- .10 Coordination study/Arc flash hazard study shop drawings
- .11 Any special warranties on equipment required (i.e. LED lighting, digital lighting control, SPDs).
- .12 Certificate of completion from all associated sub-contractors.
- .13 Cable test results and floor plans containing address labels.
- .14 System commissioning certificate and report.
- .4 Final Submittals:
  - .1 Upon acceptance of Operation and Maintenance Manual by the consultant provide the following:
    - .1 Provide one copies of final operation maintenance manuals, as well as a PDF file of the entire approved manual on a USB stick. Only one USB stick is to be provided containing both the approved manual and as-built drawings.

### **1.37 AS-BUILT DRAWINGS**

- .1 Site records:
  - .1 Contractor shall provide 2 sets of reproducible electrical drawings. Provide sets of white prints as required for each phase of the work. Mark thereon all changes as work progresses and as changes occur. This shall include field and contract changes to electrical systems.
  - .2 On a weekly basis, transfer information to reproducibles, revising reproducibles to show all work as actually installed.
  - .3 Use different colour waterproof ink for each service.
  - .4 Make available for reference purposes and inspection at all times.
- .2 As-built drawings:
  - .1 Identify each drawing in lower right hand corner in letters at least 3 mm (1/8") high as follows: - "AS-BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW ELECTRICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (date).
  - .2 Submit hard copy to consultant for approval. When returned, make corrections (if any) as directed.
  - .3 Once approved, submit completed reproducible paper as-built drawings as well as a scanned pdf file copy on USB stick with Operating and Maintenance Manuals.

---

**1.38 DEMONSTRATION AND OPERATING AND MAINTENANCE INSTRUCTIONS**

- .1 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .2 Manufacturers or their representatives are to provide demonstrations and instructions.
- .3 Use operation and maintenance manual, As-built drawings, audio visual aids, etc. as part of instruction materials.
- .4 Instruction duration time requirements as specified in appropriate sections.
- .5 Where deemed necessary, consultants may record these demonstrations on video tape for future reference.

**1.39 OCCUPANCY REQUIREMENTS**

- .1 The contractor shall provide the following documentation to the consultant's satisfaction prior to receiving occupancy. Failure to provide the proper documentation will result in the occupancy not being granted. List of required documentation:
  - .1 Final Certificates (required prior to consultant's release of conformance letter).
    - .1 Electrical Safety Authority.
    - .2 Emergency Lighting.
    - .3 Smoke Alarm and Carbon Monoxide Detector Alarm.
    - .4 Testing of Integrated Fire Protection and Life Safety Systems Report.
    - .5 Fire Alarm Verification Certificate.

**1.40 READY FOR TAKEOVER**

- .1 Complete the following to the satisfaction of the consultant prior to request for ready for takeover.
  - .1 As-built Drawings.
  - .2 Maintenance Manuals.
  - .3 System Start up.
  - .4 Instructions to Owners.
  - .5 Public Address.
  - .6 Security.
  - .7 Coordination Study / Arc Flash Hazard (including photos of each breaker).
  - .8 Telecommunications Structured Cabling.
  - .9 Lighting Control System.
  - .10 Auxiliary Systems (A/V systems, SPDs, etc.).

**1.41 TRIAL USAGE**

- .1 Consultant or owner may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.

---

**1.42 REVISION TO CONTRACT**

- .1 Provide the following for each item in a given change notice:
  - .1 Itemized list of material with associated costs.
  - .2 Labour rate and itemized list of labour for each item.
  - .3 Copy of manufacturers/suppliers invoice if requested.

**1.43 EQUIPMENT SUPPORTS**

- .1 Equipment supports supplied by equipment manufacturer: shall be installed by the electrical contractor.
- .2 Equipment supports not supplied by equipment manufacturer: fabricate from structural grade steel meeting requirements of - Structural Steel Section. Submit structural calculations with shop drawings if necessary.
- .3 Mount base mounted equipment on chamfered edge housekeeping pads, minimum of 100 mm (4") high and 150 mm (6") larger than equipment dimensions all around. This installation of this pad shall be the responsibility of the electrical contractor.
- .4 This contractor shall be responsible for providing all anchor bolts and associated formed concrete bases for lighting standards as detailed.

**1.44 SLEEVES**

- .1 Pipe sleeves: at points where pipes pass through masonry, concrete, or fire rated assemblies and as indicated.
- .2 Schedule 40 steel pipe.
- .3 Sleeves with annular fin continuously welded at midpoint:
  - .1 Through foundation walls.
  - .2 Where sleeve extends above finished floor.
- .4 Sizes: minimum 6 mm (1/4") clearance all around, between sleeve and conduit.
- .5 Terminate sleeves flush with surface of concrete and masonry walls, concrete floors on grade and 25 mm (1") above other floors.
- .6 Through foundation walls PVC sleeves are acceptable.
- .7 Fill voids around pipes:
  - .1 Caulk between sleeve and pipe in foundation walls and below grade floors with waterproof fire retardant non-hardening mastic.
  - .2 Where sleeves pass through walls or floors, provide space for firestopping. Where pipes/ducts pass through fire rated walls, floors and partitions, maintain fire rating integrity.
  - .3 Fill future-use sleeves with easily removable filler.

---

**1.45 FIRESTOPPING**

- .1 Firestopping material and installation within annular space between conduits, ducts, and adjacent fire separation.
- .2 Provide materials and systems capable of maintaining effective barrier against flame, smoke, and gases.
- .3 Comply with the requirements of CAN4-S115-M35, and do not exceed opening sized for which they have been tested.
- .4 Systems to have an F or FT rating (as applicable) not less than the fire protection rating required for closures in a fire separation.
- .5 Provide “firewrap” blanket around services penetrating firewalls. Extent of blanket must correspond to ULC recommendations. In general wrap individual conduits with approved firewrap materials on each side of firewall. Refer to architectural drawings for FT ratings. Provide 1 and/or 2 layers of firewrap with transverse and longitudinal seams overlapped and/or butted (second layer offset from first layer). Cut edges are to be sealed with aluminum foil tape. Provide 50 mm stainless steel banding at 200 mm intervals. Install firewrap to manufacturers’ recommendations for proper FT rating. Acceptable manufacturers are 3M Firemaster ductwrap or approved equal.
- .6 The firestopping materials are not to shrink, slump or sag and be free of asbestos, halogens and volatile solvents.
- .7 Firestopping materials are to consist of a component sealant applied with a conventional caulking gun and trowel.
- .8 Firestop materials are to be capable of receiving finish materials in those areas, which are exposed and scheduled to receive finishes.
- .9 Firestopping shall be inspected and approved by local authority prior to concealment or enclosure.
- .10 Install material and components in accordance with ULC certification, manufacturers instructions and local authority.
- .11 **Submit product literature and installation material on firestopping in shop drawing and product data manual.**
- .12 Acceptable manufacturers:
  - .1 Rectorseal Corporation (Metacaulk)
  - .2 Proset Systems
  - .3 3M
  - .4 Hilti
  - .5 STI Firestop

**Note: Fire stop material must conform to requirements of local authorities having jurisdiction. Contractor to confirm prior to application and ensure material used is compatible with that used by other trades on site.**

- .13 Ensure firestop manufacturer representative performs on site inspections and certifies installation. Submit inspection reports/certification at time of ready for takeover.

---

**1.46 PAINTING**

- .1 Refer to Section Interior Painting and specified elsewhere.
- .2 Apply at least one coat of corrosion resistant primer paint to ferrous supports and site fabricated work.
- .3 Prime and touch up marred finished paintwork to match original.
- .4 Restore to new condition, or replace equipment at discretion of consultant, finishes which have been damaged too extensively to be merely primed and touched up.

**1.47 ACCESS DOORS**

- .1 Supply access doors to concealed electrical equipment for operating, inspecting, adjusting and servicing.
- .2 Flush mounted 600 mm x 600 mm (24" x 24") for body entry and 300 mm x 300 mm (12" x 12") for hand entry unless otherwise noted. Doors to open 180°, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps.
- .3 Material:
  - .1 Special areas such as tiled or marble surfaces: use stainless steel with brushed satin or polished finish as directed by consultant.
  - .2 Remaining areas: use prime coated steel.
  - .3 Fire rated areas: provide ULC listed access doors
- .4 Installation:
  - .1 Locate so that concealed items are accessible.
  - .2 Locate so that hand or body entry (as applicable) is achieved.
  - .3 Installation is specified in applicable sections.
- .5 Acceptable materials:
  - .1 Le Hage
  - .2 Zurn
  - .3 Acudor
  - .4 Nailor Industries Inc.

**1.48 DELIVERY, STORAGE, AND HANDLING**

- .1 Follow Manufacturer's directions in delivery, storage, and protection, of equipment and materials. Contractor to include all costs associated with delivery storage and handling in tender price.
- .2 Deliver equipment and material to site and tightly cover and protect against dirt, water, and chemical or mechanical injury, but have readily accessible for inspection. Store items subject to moisture damage (such as controls) in dry, heated space.



---

**1.49 REPAIR, CUTTING, CORING AND RESTORATION**

- .1 Be responsible for required digging, cutting, and patching incident to work of this Division and make required repairs afterwards to satisfaction of consultant. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses.
- .2 Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
- .3 Each Section of this Division shall bear expense of cutting, patching, repairing, and replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.
- .4 Cutting, patching, repairing, and replacing pavements, sidewalks, roads, and curbs to permit installation of work of this Division is responsibility of Section installing work.
- .5 Slots, cores and openings through floors, walls, ceilings, and roofs shall be provided by this contractor but performed by a trade specializing in this type of work. This Division shall see that they are properly located and do any cutting and patching caused by its neglect to do so.

**1.50 CLEANING**

- .1 Clean interior and exterior of all electrical equipment provided including light fixture lenses.
- .2 In preparation for final acceptance, clean and refurbish all equipment and leave in operating condition.

**1.51 DISCONNECTION AND REMOVAL**

- .1 Disconnect and/or remove equipment as indicated.
- .2 Cap and conceal all redundant and obsolete connections.
- .3 Provide a list of equipment to be removed to the owner, for his acceptance of same. Remove all equipment from site, which the owner does not retain.
- .4 Store equipment to be retained by owner on site where directed by consultant.

**1.52 OWNER SUPPLIED EQUIPMENT**

- .1 Connect to equipment supplied by the owner and make operable.
- .2 Design drawings are diagrammatic and do not necessarily indicate all specific final connection requirements. For the purposes of bidding, electrical trade shall include but not be limited to provision of a junction box to connect equipment wiring tail, provision of suitable disconnecting means, and flexible connection directly to equipment.

**1.53 ENCLOSURES**

- .1 This contractor must ensure that all electrical equipment mounted in sprinklered areas is provided with an enclosure in conformance with the Electrical Safety Code.

**1.54 ELECTRICAL SYSTEMS COMMISSIONING**

- .1 This electrical contractor shall work with the building commissioning agent to perform commissioning of all electrical systems.
- .2 Refer to specification section 26 01 19 Commissioning of Electrical Systems for information on required electrical contractor participation and typical commissioning agent duties

**1.55 INTEGRATED LIFE SAFETY SYSTEM TESTING**

- .1 The Integrated Life Safety System Testing Coordinator (ITC) shall be hired by the electrical trade as indicated in specification section 26 01 20.
- .2 This electrical contractor shall work with the project Integrated Life Safety System Testing Coordinator (ITC) and participate in all phases of the Integrated Life Safety Systems testing process as specified within CAN/ULC S1001-11 (2024 Rev2 updates) as well as the electrical and architectural specifications.
- .3 During the **Planning Phase** of the Integrated Life Safety Systems Testing process this electrical contractor shall review the Integrated Testing Plan (ITP) and give written confirmation of this review and acknowledgement of affected systems under his responsibility as required by the electrical specifications per the shop drawing submittal process.
- .4 Prior to the building Integrated Life Safety Systems Testing this electrical contractor shall startup/commission/verify the operation of all systems under the responsibility of this electrical trade. This electrical trade shall give written indication of completed systems and provide copies of all inspection reports, start-up reports, commissioning reports, verification reports, etc. when requested by the ITC during the **Implementation Phase**.
- .5 Upon completion of the building Integrated Life Safety Systems Testing this electrical contractor shall rectify all deficiencies related to all systems under his responsibility during the **Testing Phase** in due time for the ITC to verify and document for the project team.

**END OF SECTION**

**Part 1            General**

**1.1            GENERAL PROVISIONS**

- .1      Conform to the General Provisions of Division 1 and Electrical General Requirements Section.
- .2      This project includes retrofitting of some areas and which will require demolition.
- .3      Allow for all remedial work in areas indicated on the drawings and as generally defined in the relevant sections of the specifications.

**1.2            SCOPE OF WORK**

- .1      The scope of work is essentially the selected disconnection and/or removal of services and/or equipment, devices etc. as indicated or required to complete the work.

**Part 2            Products**

**2.1            GENERAL**

- .1      This Division is to liaise with the Owners or Consultant for equipment being removed that may be suitable for reuse to that specified or handed over to the owner.
- .2      This Division to take full responsibility for any special tools or equipment required to disassemble or remove material from building.

**Part 3            Execution**

**3.1            GENERAL**

- .1      The general requirements are indicated on the drawings and on the outline specification in Division 1.
- .2      The general execution of the demolition is to be carried out in a clean and efficient manner.
- .3      Demolition of existing ceiling, walls etc., to facilitate removal of existing services or equipment or installation of new to be kept to a minimum and then restored to match existing.
- .4      All openings or holes created by removal of existing electrical systems which are not being reused are to be patched with the same material surrounding surfaces.
- .5      All new holes and openings to facilitate electrical systems are to be patched to match surrounding surfaces.
- .6      Protect all existing furnishings materials and equipment. Any damage occurring as a result of the work of this Division shall be repaired or replaced at the expense of this Division.

- .7 Where work involves breaking into or connecting to existing services, carry out work at times directed by the Owners in an expedient manner with minimum disruption to the facility and systems downtime.
- .8 Where unknown services are encountered immediately advise Consultant and confirm findings in writing.
- .9 Where the location of any services has been shown on the plans, such information is not guaranteed. It is this Division's responsibility to verify locations, etc., immediately after moving on site. Should for any reason the information obtained necessitates changes in procedure or design, advise the Consultant at once. If verification of existing conditions is not done at the outset and any problems arise, the responsibility for same is entirely this Division's.
- .10 Disconnect and/or remove equipment, devices, cabling, services, etc. as indicated.
- .11 Remove all redundant and obsolete systems, connections, and wiring.
- .12 Provide a list of equipment to be removed to the owner, for their acceptance of same. Remove all equipment from site that the owner does not retain.
- .13 Maintain equipment to be retained by owner on site where directed by consultant.
- .14 Demolition of all parts of the work must be completed within the confines of the work area and in such a way as the dust produced and risk to injury of will not adversely affect the building users.
- .15 Demolished areas of the existing building will remain in their current use in some cases. Demolition in these areas must be kept to the minimum required to complete the work.
- .16 Demolition shall take place within areas isolated from all other areas with appropriate hoarding, scaffolding, netting, fencing or other means of security between building users and the work.

**END OF SECTION**

**Part 1 General**

**1.1 GENERAL REQUIREMENTS**

- .1 Conform to the general conditions.
- .2 Conform to the Electrical Contract General Requirements Section 26 01 16.
- .3 Provide labour and material to conduct the commissioning process as outlined in this specification section.
- .4 The electrical contractor shall perform the closeout requirements specified in conjunction with the independent Commissioning Consultant (CC) retained by the owner.

**Part 2 Products**

**2.1 PRODUCTS**

- .1 The electrical contractor and manufacturers shall provide all instrumentation and equipment necessary to conduct the tests specified. The electrical contractor shall advise the electrical consultants of instrumentation to be used and the dates the instruments were calibrated.

**Part 3 Execution**

**3.1 COMMISSIONING PROCESS**

- .1 The commissioning process consists of:
  - .1 Shop Drawings and Record Drawings
  - .2 Installation inspection and equipment verification
  - .3 Independent testing contractor
  - .4 Testing of equipment and systems
  - .5 Commissioning meetings
  - .6 Operating and maintenance manuals
  - .7 Operating training
  - .8 Commissioning Agent testing
  - .9 Systems Demonstration and turnover
  - .10 Testing forms
  - .11 Warranties

**3.2 SHOP DRAWINGS AND RECORD DRAWINGS**

- .1 Conform to Section 26 01 16 requirements for shop drawings and record drawings.

### **3.3 INSTALLATION INSPECTION AND EQUIPMENT VERIFICATION**

- .1 The electrical contractor shall co-ordinate with the electrical consultant who will conduct general review the electrical installation.
- .2 The electrical contractor shall complete the equipment verification forms for each piece of equipment. The forms shall be included in the operating and maintenance manual. The equipment data shall include:
  - .1 Manufacturers name, address and telephone number
  - .2 Distributors name, address and telephone number
  - .3 Make, model number and serial number
  - .4 Voltage and current ratings

### **3.4 INDEPENDENT TESTING CONTRACTOR**

- .1 The Independent Testing Contractor (ITC) shall be hired by the contractor and shall issue reports to the electrical consultant.
- .2 The ITC shall conduct, as detailed in the Section 26 01 16 load balancing measurements.

### **3.5 TESTING OF EQUIPMENT AND SYSTEMS**

- .1 The electrical contractor shall be responsible for all tests detailed in the Section 26 01 16 and those tests required by a manufacturer as part of their installation requirements.
- .2 The electrical contractor shall schedule all tests, which shall be witnessed by the electrical consultant or the commissioning consultant. The contractor shall complete and sign the testing forms.
- .3 The electrical contractor shall conduct tests on the following equipment as a minimum. Refer to the individual specification sections for test procedures.
  - .1 Co-ordination study
  - .2 Distribution panels
  - .3 Power and lighting panels
  - .4 Surge protection devices
  - .5 Fire alarm
  - .6 Public address
  - .7 Cables
  - .8 Lighting controls
- .4 When all testing has been completed and all mechanical and electrical systems are operational the contractor shall conduct system load balance measurements, infra red test and harmonics tests.

### **3.6 COMMISSIONING MEETINGS AND REPORTING**

- .1 The electrical contractor shall include the schedule for all tests in the construction schedule.
- .2 The commissioning meetings shall occur during the regular construction meetings. The testing schedules and the results of all tests shall be reviewed.

- .3 All testing forms and reports associated with the electrical systems shall be directed to the electrical consultant with copies to the architect, commissioning consultant and the owner.
- .4 The forms and reports to be issued shall include:
  - .1 Shop drawings, issued and accepted
  - .2 Equipment verification forms
  - .3 Testing forms
  - .4 Reports resulting from tests
  - .5 Testing schedule
  - .6 Minutes of commissioning meetings
  - .7 Manufacturers Certificates

### **3.7 OPERATING AND MAINTENANCE MANUAL**

- .1 Conform to the Section 26 01 16 the requirements of the O&M manuals.

### **3.8 OPERATOR TRAINING**

- .1 Conform to Section 26 01 16 for requirements for instructions to the Building Owner for each system and equipment.
- .2 The training shall be provided by qualified technicians or electricians and shall be conducted in a classroom and at the equipment or system.
- .3 The training sessions shall be scheduled, co-ordinated and video taped by the commissioning consultant.
- .4 Each training session shall be structured to cover:
  - .1 The operating and maintenance manual
  - .2 Operating procedures
  - .3 Maintenance procedures
  - .4 Trouble-shooting procedures
  - .5 Spare parts
  - .6 Submit a course outline to the electrical consultant before training commences. Provide course documentation for up to eight people.
- .5 The training session shall be scheduled and co-ordinated by the commissioning consultant. The commissioning consultant shall video tape the sessions.
- .6 Training shall be provided for the following systems:

Fire Alarm System	2 hours minimum
Public Address System	1 hour minimum
Electrical System	8 hours minimum
Lighting Control System	4 hours minimum
- .7 The electrical contractor shall conduct a walk through of the installation. During the walk through the electrical contractor shall:
  - .1 Identify equipment.

- .2 Identify electrical panels.
- .3 Identify starters and disconnects.
- .4 Review the electrical power distribution.
- .5 Review the light power distribution.
- .6 Review the switchgear.
- .7 Review the general maintenance procedures.
- .8 Review the lighting controls operation.

### **3.9 COMMISSIONING CONSULTANT**

- .1 A commissioning consultant (CC) will be retained by the owner. The commissioning consultant will report to the owner.
- .2 The CC responsibilities shall include:
  - .1 Preparing the commissioning plan
  - .2 Co-ordinating with the contractor to schedule tests
  - .3 Preparing a test form manual
  - .4 Witnessing selected tests
  - .5 Receiving all test forms
  - .6 Co-ordinating the contractors training
  - .7 Chair the commissioning meetings
- .3 The electrical contractor shall co-operate with the CC.
- .4 The electrical contractor shall provide assistance to the CC and have personnel available during the performance testing procedure. Each electrical system shall be tested in the operational mode.

### **3.10 ELECTRICAL SYSTEM DEMONSTRATION AND TURNOVER**

- .1 The system demonstration and turnover to the owner shall occur when:
  - .1 The installation is complete.
  - .2 The acceptance test conducted by the electrical consultant has been completed successfully.
  - .3 Training has been completed.
  - .4 Equipment Operating and Maintenance Manuals have been accepted.
  - .5 System operating manuals have been accepted.
  - .6 Shop-drawings have been updated.
  - .7 As-built drawings have been completed.
  - .8 The commissioning process has been completed successfully and system operation accepted by the electrical consultant and commissioning consultant.
- .2 The systems demonstration shall be conducted by the electrical contractor and manufacturers. The demonstration shall cover a physical demonstration of equipment installation and operation.



---

**3.11 TESTING FORMS**

- .1 The electrical contractor and manufacturers shall fill out the forms listed in this section or provide other forms. The forms must be approved by the electrical consultant and the owner before they are used.

**3.12 WARRANTIES**

- .1 Equipment and system warranties shall not begin until the system demonstration and turnover has been conducted successfully and accepted by the owner.
- .2 The electrical contractor shall fill out the warranty form listing the equipment and systems and the start and finishing dates for warranty.
- .3 Refer to the Division 1 and Division 26 Sections for the requirements during the warranty period.
  - .1 Furnish complete catalog data for manufactured items of equipment to be used in the work to consultant for review within 14 days after award of Contract.
  - .2 Upon receipt of reviewed shop drawing, product is to be ordered immediately.
  - .3 Provide a complete list of shop drawings to be submitted prior to first submission.

**3.13 COMMISSIONING PROCESS ALLOCATION**

- .1 The commissioning process shall be allocated a value equal to 5% of the contract. The electrical contractor may draw from this allocation as the commissioning process is completed.
- .2 The electrical contractor shall submit all test and verification forms. The consultant will use these forms to calculate percentage complete.
- .3 The electrical contractor may claim up to 3% of the contract from this allocation leading up to performance testing. The remaining 2% shall not be paid out until the performance testing, O & M manuals and training have been completed satisfactorily.

**END OF SECTION**

**Part 1                      General**

**1.1                      WORK INCLUDED**

- .1      Section 21 02 51 – FIRE PROTECTION GENERAL REQUIREMENTS and DIVISION 1
- .2      Section 21 12 13 – FIRE SUPPRESSION STANDPIPE SYSTEM
- .3      Section 21 13 13 – WET PIPE FIRE SUPPRESSION
- .4      Section 21 13 16 – DRY-PIPE SPRINKLER SYSTEMS
- .5      Section 23 02 52 – HVAC GENERAL REQUIREMENTS and DIVISION 1
- .6      Section 23 33 17 – SMOKE CONTROL DAMPERS
- .7      Section 26 01 16 – ELECTRICAL GENERAL REQUIREMENTS and DIVISION 1
- .8      Section 28 31 25 – FIRE ALARM SYSTEM (ADDRESSABLE)
- .9      Applicable building systems in item 1.3.10 and as included in all project DIVISIONS.

**1.2                      REFERENCES**

- .1      OBC-2024, Ontario Building Code Compendium.
- .2      CAN/ULC-1001, Integrated System Testing of Fire Protection and Life Safety Systems.
- .3      CAN/ULC-S524, Installation of Fire Alarm Systems.
- .4      CAN/ULC-S537, Verification of Fire Alarm Systems.
- .5      CAN/ULC-S573, Installation of Ancillary Devices Connected to Fire Alarm Systems
- .6      CAN/ULC-S561, Installation and Service for Fire Signal Receiving Centres and Systems
- .7      CAN/ULC-S112, Standard Method of Fire Test of Fire Damper Assemblies
- .8      NFPA 13, Fire Sprinkler Systems
- .9      NFPA 17A, Standard for Wet Chemical Extinguishing Systems
- .10     NFPA 92, Standard for Smoke Control Systems
- .11     NFPA 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

**1.3                      OVERVIEW**

- .1      All work shall be performed in accordance with CAN/ULC-1001 Integrated System Testing of Life Safety and Fire Protection Systems, latest edition.
- .2      The Building Code has adopted CAN/ULC-1001 as the standard to comply with Integrated System Testing of Life Safety and Fire Protection Systems. The scope of this project shall follow the strict guidelines laid out in CAN/ULC-1001 for Integrated Testing Planning, review, and implementation.

- .3 The Integrated Testing Plan (ITP) will provide a full overview of all integration points of life safety and fire protection systems. The ITP will be submitted for review to the design professionals and Authority Having Jurisdiction (AHJ). Upon the successful completion of the ITP and all the respective systems, the Integrated Testing Coordinator (ITC) will provide a schedule to the design professionals, the AHJ, and all required participating members for the ITP to be conducted.
- .4 The ITC will review all drawings, specifications, sequence of operations, and methodology prepared by the design professionals, complete with the contractor's shop drawings and manufacture requirements.
- .5 The ITP shall be coordinated with all sub-contractors and suppliers as outlined in item 1.1.
- .6 The ITC will conduct the ITP and will sign each integrated test form, complete with signatures from each participating member of the integrated systems.
- .7 The ITC shall witness all integrations and not rely on the CAN/ULC-S537 Verification Inspection Report for fire protection system integration testing; however, the ITC may attend the verification to validate the testing.
- .8 The ITC will provide all work and ITP including functional documentation, prescribed in CAN/ULC-1001. Such testing and documentation have been deemed to satisfy OBC 2024 Sentence 3.2.9.
- .9 The ITC will provide PDF and digital media copy of the buildings ITP and Integrated System Report (ITR) for the building owner's use, re-testing, and reproduction purpose.
- .10 The systems applicable to the function testing include but not limited to:
  - .1 Fire Alarm System (including sequence of operations) and Monitoring
  - .2 Sprinkler Systems (wet, dry, standpipe)
  - .3 Magnetic Door Holds
  - .4 Smoke and CO Alarms
  - .5 Smoke Damper Assemblies
  - .6 HVAC Shutdown

## **Part 2 Products**

### **2.1 TESTING AND PLANNING**

- .1 The Integrated Testing Process must include following:
  - .1 Planning phase by the testing coordinator.
  - .2 Integrated testing plan review by the design professionals.
  - .3 Integrated testing plan review by the AHJ.
  - .4 Review of sequence of operations.
  - .5 System documentation.

- .6 Integrated System Testing Plan consisting of:
  - .1 Project description.
  - .2 Project contacts including applicable project responsibilities.
  - .3 Overview and description of each integrated system.
  - .4 System integrations and functional objective of each integrated system.
  - .5 Integration matrix of all integrated system complete with integration type, normal mode and off-normal mode.
  - .6 Test protocols and procedures of each integrated system,
  - .7 Notifications.
  - .8 Personnel safety.
  - .9 Phased occupancies.
  - .10 Pre-testing documentation checklist.
  - .11 Pre-testing documentation acknowledgement forms.
  - .12 Testing forms.
  - .13 Ongoing integrated system testing forms.
  - .14 Integrated system testing completion form.
  - .15 Integrated testing notes.

## **2.2 RESPONSIBILITIES**

- .1 General Contractor:
  - .1 General Contractor to employ the services of the ITC firm as a sub-contractor. Refer to item 2.6.
  - .2 Coordinate with the ITC for schedule and witness testing.
  - .3 Coordinate all responsible sub-contractors.
  - .4 Confirm all respective systems listed in item 1.3.10 are complete and fully operational, prior to the ITC commencing the functional testing.
  - .5 Provide reports for respective systems such as, but not limited to; TSSA elevator inspection reports, start-up reports, commissioning reports, verification reports.
  - .6 Participate in the ITP and provide function testing of equipment within the mechanical, electrical, and fire protection contract packages.
  - .7 Allow for any cost associated to re-testing of the ITP due to failures or insufficient work.
  - .8 Allow for any cost associated with phased occupancy and phased Integrated Testing work.

- .2 HVAC Contractor:
  - .1 The HVAC Contractor shall confirm all mechanical systems listed in item 1.3.10 are complete and fully operational, prior to the ITC commencing the functional testing.
  - .2 Provide system reports such as, but not limited to; air balancing reports, TSSA inspection reports, start-up reports, commissioning reports, verification reports. The Mechanical Contractor shall further provide written confirmation that all mechanical systems are installed and operating as intended by the contract documents and sequence of operations.
  - .3 Participate in the ITP and provide function testing of equipment within the mechanical contract package.
  - .4 Allow for any cost associated to re-testing of the ITP due to failures or insufficient work.
  - .5 Allow for any cost associated with phased occupancy and phased Integrated Testing work.
- .3 Fire Protection Contractor:
  - .1 The Fire Protection Contractor shall confirm all fire protection systems listed in item 1.3.10 are complete and fully operational, prior to the ITC commencing the functional testing.
  - .2 Provide system reports such as, but not limited to; NFPA 13 letter, NFPA 20, letter, above ground sprinkler piping letter, below ground sprinkler letter, system designer letter, start-up reports, commissioning reports, verification reports. The Fire Protection Contractor shall further provide written confirmation that all fire protection systems are installed and operating as intended by the contract documents and sequence of operations.
  - .3 Participate in the ITP and provide function testing of equipment within the fire protection contract package.
  - .4 Allow for any cost associated to re-testing of the ITP due to failures or insufficient work.
  - .5 Allow for any cost associated with phased occupancy and phased Integrated Testing work.
- .4 Electrical Contractor:
  - .1 The electrical contractor shall confirm all electrical systems listed in item 1.3.10 are complete and fully operational, prior to the ITC commencing the functional testing.
  - .2 Provide system reports such as, but not limited to; ESA Inspection Certificate, Fire Alarm Verification, TSSA Inspection, Generator Start-up report, commissioning reports, and verification reports. The Electrical Contractor shall further provide written confirmation that all electrical systems are installed and operating as intended by the contract documents and sequence of operations.
  - .3 Participate in the ITP and provide function testing of equipment within the electrical contract package.

- .4 Allow for any cost associated to re-testing of the ITP due to failures or insufficient work.
- .5 Allow for any cost associated with phased occupancy and phased Integrated Testing work.
- .5 Equipment Manufacturers:
  - .1 Where required, shall confirm all respective systems listed in item 1.3.10 are complete and fully operational, prior to the ITC commencing the functional testing.
  - .2 Participate in the ITP and provide function testing of equipment within the respective contract package.
- .6 Design Professionals:
  - .1 The design professional shall include, but not be limited to, the project Architect, Electrical and Mechanical Consultants, Fire Protection Engineer, Elevator Consultant, etc.
  - .2 Shall review the ITP, and upon review, accept the ITP as the agreed ITP for implementation.
  - .3 The design professionals are responsible for design. Upon an unsuccessful test, the failure will be documented and provided to the respective design professionals for review and action.

## 2.3 NOTIFICATION OF TESTING PLANNING PROCESS

- .1 The ITC shall work with the General Contractor, Owner, sub-contractors, design professionals, and the AHJ to provide a schedule for the implementation of the ITP.
- .2 The ITC shall obtain contact names, contact details, and system responsibilities for all project design professionals.
- .3 The ITC shall provide notification to the integrated testing participants seven days prior to the date and time for the implementing of the ITP.
- .4 Prior to testing, the ITC shall obtain written acknowledgement for acceptance and understanding of the ITP by all project design professionals and contractors per 1001 Section 5 and Appendix B. Include ITP Review & Acceptance acknowledgement sheet in the ITR. **Refer to Figure 1.**
- .5 Prior to testing, the ITC shall obtain written acknowledgement for acceptance testing of site readiness from all project design professionals and contractors per 1001 Section 5 and Appendix B. Failure to obtain acknowledgement prior to implementation of integrated testing may invalidate the results and could result in delays by the design professionals issuing conformance. Include ITP Acceptance Testing acknowledgement sheet in the ITR. **Refer to Figure 2 and Figure 3.**
- .6 In the event of building occupants, the ITC shall provide at a minimum, 48 hour notice of the implementation of the integrated testing. Notification shall be provided via written notices posted at each building entrance.

- .7 Partial occupancies shall employ this process for each individual occupancy and shall clearly identify the extent of to which the partial occupancy applies when obtaining written confirmations.
- .8 Figures 1 through 3 of this specification section are indicated as informative and are for information only regarding the intent for required written acknowledgement gathering by the ITC. All designers and trades listed may not apply to all projects. The ITC shall be responsible for determining all required designers and contractors for the project based on the contact information from the ITP.

## **2.4 TESTING IMPLEMENTATION PROCESS**

- .1 Implementation of the integrated test shall follow all job site and personnel safety requirements set out in the contract and General Contractors requirements.
- .2 The ITC shall define:
  - .1 Personnel safety protocols
  - .2 Special hazards
  - .3 Team communications
  - .4 Occupant notification of emergencies
- .3 The integrated system test shall follow the methodology and process outlined in CAN/ULC-1001 as the requirement for this project.
  - .1 Provide the final ITP to the Consultant 14 days prior to scheduled implementation and test.
- .4 The respective contractors and manufactures are responsible to start-up and function test their respective systems, for observation and witnessing by the ITC. The ITC will record the results, and the respective contractor and manufacture will restore the system to a normal condition. Upon successful testing the contractor and manufacture will initial the respective integrated testing from adjacent to their respective test.
- .5 Upon a failure of a test, the ITC will document the failure and continue with the testing of other integrations. The respective contractor and manufacture will document the failure, notify they design professional, and correct the failure under the direction of the design professional.
  - .1 The ITC will re-test the unsuccessful integration after the correction has been documented and verified.
- .6 Upon a failure of a device (such as a smoke detector), the contractor may immediately replace the device, and the ITC may continue to test the integration. The device failure maybe documented but shall not result in a failed integrated test.
- .7 The ITC shall include in quote costs associated with site testing of all integrated devices. ITPs and testing procedures which include only for a sampling of devices will not be accepted. ITPs and testing procedures which rely solely on inspection reports, start-up reports, commissioning reports, or verification reports, etc. will not be accepted.

- .8 Partial occupancies shall employ this process for each individual occupancy and shall clearly identify the extent to which the partial occupancy applies when obtaining written confirmations.
- .9 Upon successfully completing the ITP, the ITC shall provide the ITR to the design professionals and building owner.

## **2.5 QUALITY CONTROL**

- .1 The ITC must meet the following criteria to be considered acceptable for this project:
  - .1 Firms regular engaged with contractors in function testing, fire alarm verification, sprinkler system testing, annual inspections and maintenance of fire and life safety systems.
  - .2 Firms knowledgeable and experience of the respective Codes and Standards of the particular project, including but not limited to; Building Codes, Fire Codes, ULC Standards, CSA Standards, and NFPA Standards.
  - .3 Firms must be a member in good standing of the Canadian Fire Alarm Association (CFAA).
  - .4 Vendors must be a 3<sup>rd</sup> party and independent from the fire protection and life safety system installation company present on the project in accordance with ULC Certification Bulletin 2020-08.
  - .5 Firms must maintain operations in the province of Ontario for at least five years.
  - .6 Vendors must be a ULC Listed Integrated Systems Testing Service Provider and posses a ULC Integrated Fire Protection and Life Safety Certification. The ULC Certificate must be valid from the date of project award until the completed Integrated Testing Report. The ULC certification level shall be that which is applicable to the building life safety systems level of complexity for the project.
    - .1 Submit the ULC Certificate upon project award to the Consultant's office complete with Applicant ID Number.

## **2.6 QUALIFIED INTEGRATED TESTING COORDINATOR**

- .1 Bidders may choose from the experienced ITC Firms listed below or local branches of these companies noted in the vicinity of this project and are acceptable as a sub-contractor to the Electrical Contractor:
  - .1 Lonergan Engineering  
Aurora, Ontario L4G 3V51
  - .2 Great Lakes Fire Consulting & Engineering Group  
Windsor, Ontario
- .2 Other experienced ITC Firms must submit in writing, to the Consultant's office, confirmation of the items listed in the Quality Control criteria above, prior to tender close to be considered as an acceptable bidder.

**END OF SECTION**



**Figure 1 – Example Pre-Test ITP Acknowledgement (Typical Design Professionals): Informative**

INTEGRATED SYSTEMS WRITTEN ACKNOWLEDGEMENT REVIEW AND ACCEPTANCE OF INTEGRATED TEST PLAN (EXAMPLE)			
Per Item 5.2.8 and Section B9.1 of CAN/ULC S1001 (latest version), the respective design professionals shall indicate written confirmation to the Testing Coordinator acceptance of the Integrated systems Test Plan according to the intent of the project design documents.			
List of Design Professionals		Company/Representative	Design Responsibility
Architect	Company Name:		
	Designer Name:		
	Signature		
Electrical Engineer	Company Name:		
	Designer Name:		
	Signature		
Mechanical Engineer	Company Name:		
	Designer Name:		
	Signature		
Fire Protection Engineer (sprinkler)	Company Name:		
	Designer Name:		
	Signature		
(typical responsible consultant on project)	Company Name:		
	Designer Name:		
	Signature		

**Figure 2 – Example Pre-Test Trade Site Ready Acknowledgement (Typical Project Trades): Informative**

PRE-TESTING INTEGRATED SYSTEMS WRITTEN ACKNOWLEDGEMENT (EXAMPLE)			
Per Item 5.3.1.(B) and Section B8.1 of CAN/ULC S1001 (latest version), the respective installing contractors shall indicate written confirmation to the Testing Coordinator that their respective life safety systems have been installed in accordance with the design are ready for integrated testing as outlined within the Integrated Systems Testing Plan.			
List of Installing Trades		Company/Representative	System Responsibilities
General Contractor	Company Name:		
	Name:		
	Signature		
Electrical Contractor	Company Name:		
	Name:		
	Signature		
Mechanical Contractor	Company Name:		
	Name:		
	Signature		
Sprinkler Contractor	Company Name:		
	Name:		
	Signature		
Elevator Contractor	Company Name:		
	Name:		
	Signature		
(typical responsible trade on project)	Company Name:		
	Name:		
	Signature		

**Figure 3** – Example Pre-Test Designer Site Ready Acknowledgement (Typical Design Professionals):  
Informative

PRE-TESTING INTEGRATED SYSTEMS WRITTEN ACKNOWLEDGEMENT (EXAMPLE)			
Per Item 5.3.1.(A) and Section B8.1 of CAN/ULC S1001 (latest version), the respective design professionals shall indicate written confirmation to the Testing Coordinator that the site is ready for integrated systems testing per the descriptions and integrations outlined within the Integrated Systems Testing Plan.			
List of Design Professionals		Company/Representative	Design Responsibility
Architect	Company Name:		
	Designer Name:		
	Signature		
Electrical Engineer	Company Name:		
	Designer Name:		
	Signature		
Mechanical Engineer	Company Name:		
	Designer Name:		
	Signature		
Fire Protection Engineer (sprinkler)	Company Name:		
	Designer Name:		
	Signature		
(typical responsible consultant on project)	Company Name:		
	Designer Name:		
	Signature		

**Part 1 General**

**1.1 REFERENCES**

- .1 CSA C22.2 No.0.3-92, Test Methods for Electrical Wires and Cables.
- .2 CAN/CSA-C22.2 No.131-M89(R1994), Type TECK 90 Cable.

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with Electrical General Requirements Section.

**Part 2 Products**

**2.1 BUILDING WIRES**

- .1 Conductors: stranded for 10 AWG and larger.
- .2 Minimum size: 12 AWG.
- .3 Copper conductors: size as indicated, with 600 V insulation of chemically cross-linked thermosetting polyethylene material 90°C (194°F) rated T90 for indoor above grade installations and RW90 for below grade installations.
- .4 Minimum wire size shall be 8 AWG for all 120V circuits exceeding 60 meters in length.

**2.2 TECK CABLE**

- .1 Cable: to CAN/CSA-C22.2 No.131.
- .2 Conductors:
  - .1 Grounding conductor: copper.
  - .2 Circuit conductors: copper, size as indicated.
- .3 Inner jacket: polyvinyl chloride material.
- .4 Armour: aluminum.
- .5 Overall covering: polyvinyl chloride material.
- .6 Fastenings:
  - .1 One hole steel zinc straps to secure surface cables 50 mm (2") and smaller. Two hole steel straps for cables larger than 50 mm (2").
  - .2 Channel type supports for two or more cables at 1500 mm (60") centres.
  - .3 Threaded rods: 6 mm (1/4") diameter to support suspended channels.
- .7 Connectors must be suitable for:
  - .1 Installed environment and approved for use with TECK cable.

**2.3 ARMoured CABLES**

- .1 Conductors: insulated, copper minimum size as indicated above.

- .2 Type: AC90 (minimum size 12 AWG).
- .3 Armour: interlocking type fabricated from aluminum strip.
- .4 Connectors must be suitable for installed environment and approved for use with armoured cable.

### **Part 3 Execution**

#### **3.1 INSTALLATION OF BUILDING WIRES**

- .1 Install wiring from source to load through raceways as specified.
- .2 Provide separate neutral conductors for all lighting circuits and circuits originating from surge protected panels. Size raceways accordingly.

#### **3.2 INSTALLATION OF TECK CABLE 0 - 1000 V**

- .1 Group cables wherever possible on channels.
- .2 Terminate cables in accordance with Wire and Box Connectors - 0 - 1000 V Section.

#### **3.3 INSTALLATION OF ARMoured CABLES**

- .1 Group cables wherever possible.
- .2 Terminate cables in accordance with Wire and Box Connectors - 0 - 1000 V Section.
- .3 These cables are to be installed in concealed locations only. These concealed locations are considered to be stud walls and “drops” to stud walls, lighting fixtures, and ceiling mounted devices.
- .4 **These “drops” shall not be permitted to exceed 2.4 m (8'-0"). To limit these “drops” to lengths noted above provide additional branch wiring in conduit.**

**END OF SECTION**

**Part 1            General**

**1.1                SHOP DRAWINGS AND PRODUCT DATA**

- .1        Submit shop drawings and product data for cabinets in accordance with Electrical General Requirements Section.

**Part 2            Products**

**2.1                MATERIALS**

- .1        Junction and pull boxes must conform to CSA C22.2 No. 40 (latest edition)

**2.2                JUNCTION AND PULL BOXES**

- .1        Welded steel construction with screw-on flat covers for surface mounting.
- .2        Covers with 25 mm (1") minimum extension all around, for flush-mounted pull and junction boxes.

**Part 3            Execution**

**3.1                JUNCTION AND PULL BOXES INSTALLATION**

- .1        Install pull boxes in inconspicuous but accessible locations.
- .2        Install junction and pull boxes so as not to exceed 30 m (100') of conduit run between pull boxes and in conformance with the Electrical Safety Code.

**3.2                IDENTIFICATION**

- .1        Provide equipment identification in accordance with General Electrical Requirements Section.
- .2        Install size 2 identification labels indicating system name, voltage and phase.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1        Outlet boxes, conduit boxes, and fittings must conform to CSA C22.2 No. 18 (latest edition).

**Part 2            Products**

**2.1            OUTLET AND CONDUIT BOXES GENERAL**

- .1        Size boxes in accordance with CSA C22.1.
- .2        102 mm (4") square or larger outlet boxes as required for special devices.
- .3        Gang boxes where wiring devices are grouped.
- .4        Blank cover plates for boxes without wiring devices.
- .5        Combination boxes with barriers where outlets for more than one system are grouped.

**2.2            SHEET STEEL OUTLET BOXES**

- .1        Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 mm x 50 mm x 64 mm (3" x 2" x 2½") or as indicated. 102 mm (4") square outlet boxes when more than one conduit enters one side with extension and plaster rings as required. Iberville 1104 Series.
- .2        Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit **in utility rooms**, minimum size 102 mm x 57 mm x 38 mm (4" x 2¼" x 1½"). Iberville 1110 Series.
- .3        102 mm (4") square or octagonal outlet boxes for lighting fixture outlets.
- .4        102 mm (4") square outlet boxes with extension and plaster rings for flush mounting devices in finished 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            FIRE RATED POKE THRU FLOOR BOXES**

- .1        Fire rated poke-thru floor boxes where indicated shall be complete with the following features:
  - .1        4" Poke -Thru.
  - .2        2-Gang Brushed Aluminum Combination Carpet and Tile.

- .3 2 Hour Fire Rated
- .4 Cast iron construction watertight with scrub water exclusion rated cover.
- .5 Finish to be confirmed by architect.
- .2 Manufacturers:
  - .1 Refer to floor box schedule for further details and requirements.  
Approved equal Manufactures:
    - .1 Hubbell
    - .2 Wellmark Electric Inc.

## 2.6 CONDUIT BOXES

- .1 Cast FS or FD feraloy boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle **in areas (other than utility rooms) where surface conduit is used.**

## 2.7 FITTINGS- GENERAL

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of debris.
- .3 Conduit outlet bodies for conduit up to 32 mm (1- 1/4") 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 (1/4") of opening.
- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.
- .5 Outlets if unwired are to be provided with blank coverplates to suit related sections of this specification.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1        CSA C22.2 No.65-1956(R1965) Wire Connectors.

**Part 2            Products**

**2.1            MATERIALS**

- .1        Pressure type wire connectors: with current carrying parts of copper sized to fit copper conductors as indicated.
- .2        Fixture type splicing connectors: with current carrying parts of copper sized to fit copper conductors 10 AWG or less.
- .3        Clamps or connectors for armoured cable, mineral insulated cable, and flexible conduit, as required.

**Part 3            Execution**

**3.1            INSTALLATION**

- .1        Remove insulation carefully from ends of conductors and:
  - .1        Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.
  - .2        Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2 No.65.
  - .3        Install fixture type connectors and tighten. Replace insulating cap.

**END OF SECTION**



**Part 1**            **General**  
**Not Applicable.**

**Part 2**            **Products**

**2.1**                **MATERIALS**

- .1            Grounding equipment must conform to CSA C22.2 No 41 (latest edition).

**2.2**                **EQUIPMENT**

- .1            Insulated grounding conductors: green with insulation type that matches specified phase conductors. Gauge shall be in conformance with the latest edition of the Electrical Safety Code to suit required installation conditions.
- .2            Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.

**Part 3**            **Execution**

**3.1**                **INSTALLATION GENERAL**

- .1            Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. **Where EMT is used, run ground wire in conduit.**
- .2            Install connectors in accordance with manufacturer's instructions.
- .3            Protect exposed grounding conductors from mechanical injury.
- .4            Use mechanical connectors for grounding connections to equipment provided with lugs.
- .5            Soldered joints not permitted.
- .6            Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
- .7            Install separate ground conductor to outdoor lighting standards.

**3.2**                **EQUIPMENT GROUNDING**

- .1            Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, duct systems, frames of motors, starters, control panels, building steel work, distribution panels, and outdoor lighting.

**3.3 COMMUNICATION SYSTEMS**

- .1 Install grounding connections for telephone, fire alarm and computer network systems as follows:
  - .1 Telephones: make telephone grounding system in accordance with telephone company's requirements.
  - .2 Fire alarm and computer network systems as indicated.

**3.4 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Electrical General Requirements Section.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.
- .4 Disconnect ground fault indicator during tests.

**END OF SECTION**

**Part 1            General**

**1.1            APPLICATION**

- .1    Seismic restraint is becoming more prominent with improved soil testing equipment. Seismic requirement is not site specific by geographical area but determined by site soil conditions.
- .2    Where the structural engineer or architect documents have  $I_e \cdot S_a(0.2) \cdot F_a < 3.5$  seismic is not required on the electrical systems.
- .3    Where the structural engineer or architect documents have  $I_e \cdot S_a(0.2) \cdot F_a \geq 3.5$  seismic is required on the electrical systems.
- .4    Seismic will always be required on fire protection systems when required by NFPA codes.
- .5    Seismic will always be required on any “Disaster Relief Building.” For example, hospitals, police stations, ambulance building, etc.
- .6    When it is unclear in the tender documents request information from the structural engineer or architect for clarification.

**1.2            SECTION INCLUDES**

- .1    Seismic Requirements for free standing equipment and other similar systems.
- .2    Seismic Requirements for single rod hanger supports for conduit, and other similar systems.
- .3    Seismic Requirements for trapeze type supports for bus tray, conduit, and other similar systems.

**1.3            REFERENCES**

- .1    Building Officials and Code Administrators National Building Code (BOCA) (latest edition).
- .2    Ontario Building Code (OBC), (latest edition).
- .3    Uniform Building Code (UBC), (latest edition).
- .4    International Building Code (IBC), (latest edition).
- .5    California Building Code (CBC), (latest edition).

**1.4            QUALITY ASSURANCE**

- .1    The contractor shall provide pre-engineered seismic restraint systems to meet total design lateral force requirements for support and restraint of free standing electrical equipment, conduit, cable trays and other similar suspended systems and equipment as determined by seismic restraint designer.

- .2 System Supports/Restraints: Firms regularly engaged in the manufacture of products of the types specified in this section, whose products have been in satisfactory use in similar service for not less than 5 years.
- .3 Bolted framing channels and fittings shall have the manufacturers name, part number, and material heat code identification number stamped in the part itself for identification. Material certification sheets and test reports must be made available by the manufacturer upon request.
- .4 Only companies experienced in performing the work of this section shall do the installation.
- .5 All seismic restraint installations shall be independently reviewed by the Owner's representatives for compliance with project specifications.

#### **1.5 SUBMITTALS**

- .1 Submit seismic force calculations according to forces chart located on structural engineer of record's drawings. Submit pre-approved restraint selections and installation details from acceptable manufacturer specified in this section or engineer approved equal.
- .2 Restraint selection and installation details shall be pre-approved by a professionally licensed engineer with at least 5 years of experience in the design of seismic restraints.
- .3 Submit manufacturer's product data on strut channels including, but not limited to, types, materials, finishes, gauge thickness, and hole patterns.
- .4 Contractor to retain services of Professional Engineer, designated in local jurisdiction and submit stamped drawings. The same engineer shall provide periodic field review and final certification upon completion of the project.

The following companies are provided for information purposes:

- .1 Tecoustics Limited - 1-888-714-9596
- .2 Lampkin Structural Services – 613-830-6875
- .3 Vibro Acoustics – 1-800-565-8401
- .4 Tecoustics Vibration Control & Seismic Restraint – 905-681-6077
- .5 Gerrits Engineering 705-737-3303
- .5 All fees and associated costs for the engineering shall be the responsibility of this contractor.

#### **1.6 SEISMIC BRACING AND SUPPORT DESIGN REQUIREMENTS**

- .1 Seismic restraint designer shall co-ordinate all attachments with the structural engineer of record.
- .2 Design analysis shall include force calculations according to forces chart listed on the structural engineer of record's drawings and capacity of materials utilized for the connection of the equipment or system to the structure.
- .3 Analysis shall detail anchoring methods, bolt diameter, and embedment depth.

- .4 All seismic restraint devices shall be designed to accept without failure the calculated forces as per the applicable Building Code.

#### **1.7 DELIVERY, STORAGE, AND HANDLING**

- .1 Deliver strut systems, pipe hangers and components carefully to avoid breakage, denting, and scoring finishes. Do not install damaged equipment.
- .2 Store strut systems, pipe hangers and components in original cartons and in clean dry space; protect from weather and construction traffic.

#### **1.8 WORK FURNISHED BUT NOT INSTALLED**

- .1 The materials and systems specified in this section shall be purchased by the electrical contractor from a single seismic snubber restraint materials manufacturer to assure sole source responsibility for the performance of the seismic restraints used.
- .2 The materials and systems specified in this section can, at the contractor's option, be installed by the subcontractor who installs the electrical equipment.

#### **1.9 COORDINATION**

- .1 Coordinate size, shape, reinforcement and attachment of all housekeeping pads supporting seismically rated equipment. Concrete shall have a minimum compressive strength of 3,000 psi or as specified by the consultant.
- .2 Coordinate with seismic restraint manufacturer to locate and size structural supports underneath seismically restrained equipment (e.g. switchboards, motor control centres, transformers, and other similar equipment).

#### **1.10 DESCRIPTION OF SYSTEM**

- .1 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 electrical 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.
- .2 The work under this section shall include furnishing all labour, materials, tools, appliances, and equipment, and performing all operations necessary for the complete execution of the installation of seismic snubber restraint assemblies as shown, detailed, and/or scheduled on the drawing and/or specified in this section of the specifications.
- .3 All seismic snubber restraint assemblies shall meet the following minimum requirements:
  - .1 The snubber/restrained isolator for isolated equipment shall include a resilient element that will ensure that no un-cushioned shock can occur (this does not include cable restraints).
  - .2 It shall be possible to visually inspect the resilient material for damage and allow for replacement, if necessary.
  - .3 All snubbers are to include a maximum air gap of 0.25" (6 mm).

- .4 Seismic restraint systems shall be designed to offer seismic restraint in all directions, unless otherwise noted.
- .5 Seismic restraint capacities to be verified by an independent test laboratory or certified by a registered Professional Engineer to ensure that the design intent of this specification is realized. Verification shall be by one of the following methods:
  - .1 An NRTL (National Recognized Testing Laboratory), or laboratory recommended by VISCMA.
  - .2 Certified by a Professional Engineer with at least 5 years of experience, using industry standard methods of analysis, which employ common engineering practices. Adherence to the ratings standard within ASHRAE SPC171 and VISCMA 102-2007 is required.
  - .3 By a nationally recognized agency, such as VISCMA, that has reviewed and approved the restraint.

#### **1.11 SYSTEM DESIGN**

- .1 Seismic restraint manufacturer shall be responsible for the structural design of 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 furnish, to the seismic restraint manufacturer, 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 furnished shall include, at a minimum, basic equipment layout, length, and width dimensions, and installed operating weights of the equipment to be restrained.
- .3 All conduit etc. is to be restrained to meet code requirements. At a minimum, the seismic restraint manufacturer 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 or the housekeeping pad is to be coordinated with the seismic restraint manufacturer to ensure that adequate edge distances exist in order to obtain the desired equipment anchor capacities.

#### **1.12 ALTERNATE SYSTEMS**

- .1 Provisions of the General Conditions and Supplemental Conditions of the specifications shall govern the use of alternate systems to those specified.
- .2 Manufacturers not listed as approved in “Part 2 Materials” of this section must secure approval to bid a minimum of ten (10) days prior to the project bid date.
- .3 Uncertified internal equipment seismic restraint systems are disallowed for use on this project.

### **1.13 INSTALLATION**

- .1 Installation of all seismic restraint materials specified herein shall be accomplished following the manufacturer's written instructions. Installation instructions shall be submitted to the engineer for approval prior to the beginning of the work.

## **Part 2 Products**

### **2.1 ACCEPTABLE MANUFACTURERS**

- .1 Cooper B-Line.
- .2 Unistrut Building Systems.
- .3 Kinetics Noise Control Inc.
- .4 Mason Industries.
- .5 Engineer approved equal.

### **2.2 SEISMIC BRACING COMPONENTS**

- .1 Steel strut and bracing components shall be utilized in combinations as required to meet designed load capacities.
- .2 Fittings and accessories: Products shall be of the same manufacturer as strut and designed for use with that product.

### **2.3 BUILDING CODE REQUIREMENTS**

- .1 Seismic Zone Factors and coefficients shall be according to geographical area information table located on structural engineer of record's drawings.

### **2.4 SEISMIC SNUBBER TYPES**

- .1 GENERAL  
(Isolator/Snubber Types contained herein are per ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.) Handbook, HVAC Applications, Seismic and Wind Restraint Design)
- .2 Type J, Cable Restraints for Suspended Conduit and Trapeze
  - .1 Seismic wire rope cable restraints shall consist of steel wire strand cables, sized to resist project seismic loads, arranged to offer seismic restraint capabilities for conduit, trapeze assemblies, and suspended equipment in all lateral directions.
  - .2 Building and equipment attachment brackets at each end of the cable shall be designed to permit free cable movement in all directions up to a 45-degree misalignment. Protective thimbles shall be used at sharp connection points as required to eliminate potential for dynamic cable wear and strand breakage.
  - .3 Restraints shall be sized to the capacity of the cable or to the capacity of the anchorage, whichever is lesser.
  - .4 Seismic wire rope connections shall be made using overlap wire rope "U" clips or seismically rated tool-less wedge insert lock connectors.

- .5 Vertical suspension rods shall be braced as required to avoid potential for buckling due to vertical “up” forces. Braces shall be structural steel angle uniquely selected to be of sufficient strength to prevent support rod bending. Brace shall be attached to the vertical suspension rod by a series of adjustable straps. Clips shall be capable of securely locking brace to suspension rod without the need for hand tools.
- .6 Where clevis hanger brackets are used for seismic restraint attachment, they will be fitted with clevis internal braces to prevent buckling of the hanger brackets.
- .7 Seismic cable shall be as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed.
- .8 Seismic cable building and equipment attachment brackets shall be Model KSCA, KSCU, or KSCC as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed.
- .9 Seismic cable concrete anchor bolts shall be Model KCAB Wedge, Model KCCAB Cracked Concrete, or Model KUAB Undercut, as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed.
- .10 Seismic wire rope connectors shall be (Model KWRC - 'U' clamp) / (Model KWGC - Tool-less wedge lock) as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed.
- .11 Seismic vertical suspension stiffener rod clips shall be Model KHRC as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed.
- .12 Clevis Internal Braces shall be Model KCHB as manufactured by Kinetics Noise Control, or by other manufacturers who can meet the requirements as listed.

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 All seismic restraint systems shall be installed in strict accordance with the manufacturer’s seismic restraint guidelines manual and all certified submittal data.
- .2 Installation of seismic restraints shall not cause any change in position of equipment or piping, resulting in stresses or misalignment.
- .3 No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration isolation system specified.
- .4 Do not install any equipment, piping, duct, or conduit that makes connections with the building unless isolation is not specified.
- .5 Prior to installation, bring to the architect’s/engineer’s attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.
- .6 Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast in place inserts, or wedge-type concrete anchors. Consult structural engineer of record.



- .7 Overstressing of the building structure shall not occur from overhead support of equipment. Bracing attached to structural members may present additional stresses. The contractor shall submit loads to the structural engineer of record for approval in this event.
- .8 Brace support rods when necessary to accept compressive loads. Welding of compressive braces to the vertical support rods is not acceptable.
- .9 Provide reinforced clevis bolts where required.
- .10 Seismic restraints shall be mechanically attached to the system. Looping restraints around the system is not acceptable.
- .11 Do not brace a system to two independent structures such as a ceiling and wall.
- .12 Provide appropriately sized openings in walls, floors, and ceilings for anticipated seismic movement. Provide fire seal systems in fire-rated walls.
- .13 Torque anchor bolts according to anchor manufacturer's written instructions to resist seismic forces.
- .14 Do not install any seismic restraint for equipment, cable trays or conduit that compromises isolation specified.
- .15 Hold down clamps must be used to attach conduits and/or cables to all trapeze members before applying restraints.
- .16 Conduit crossing building seismic or expansion joints, passing from building to building, or supported from different portions of the building shall be installed to allow differential support displacements without damaging the conduit, equipment connections, or support connections. Conduit offsets, loops, anchors, and guides shall be installed as required to provide specified motion capability and limit motion of adjacent piping.
- .17 Coring is not permitted for the installation of concrete anchors. Use ground penetrating radar or equivalent method of embedment item detection to locate all embed items including reinforcing steel and electrical conduits. Concrete reinforcing steel and electrical conduits shall not be cut or damaged under any circumstances.

### **3.2 EXECUTION**

- .1 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.
- .2 If mounting hole diameter exceeds bolt diameter by more than 0.125" (3 mm), reduce clearance in hole with epoxy grout, flanged elastomeric bushings or welded washer.
- .3 Housekeeping Pads must be adequately reinforced and adequately sized for proper installation of equipment anchors. Refer to seismic restraint manufacturer's written instructions.

### **3.3 INSPECTION**

- .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 Upon completion of the installation of all seismic restraint devices herein specified, the local representative of the seismic restraint manufacturer shall, at the contractor's request, inspect the completed system and report in writing any installation errors, improperly selected snubber devices, or other fault in the system which could affect the performance of the system.
- .3 The installing contractor shall submit a report upon request 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.

### **3.4 CONDUIT**

- .1 Seismically restrain all electrical conduit. Use Type J Cable Restraints for all conduit supported by vibration isolation hanger assemblies. Brace all conduit to code requirements (IBC or TI-809-04) or in conformance with SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.) "Seismic Restraint Manual Guidelines for Mechanical Systems", Second Edition (Remaining Codes).

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES**

- .1 Canadian Standards Association (CSA)
  - .1 CAN/CSA C22.2 No.18, Outlet Boxes, Conduit Boxes, and Fittings.
  - .2 CSA C22.2 No.56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .3 CSA C22.2 No.83, Electrical Metallic Tubing.
  - .4 CSA C22.2 No.211.2, Rigid PVC (Unplasticized) Conduit.
  - .5 CAN/CSA C22.2 No.227.3, Flexible Nonmetallic Tubing.

**Part 2            Products**

**2.1                CONDUITS**

- .1 Epoxy coated conduit: to CSA C22.2 No.45, with zinc coating and corrosion resistant epoxy finish inside and outside.
- .2 Electrical metallic tubing (EMT) with couplings: to CSA C22.2 No.83.
- .3 Rigid PVC conduit: to CSA C22.2 No.211.2.
- .4 Flexible metal conduit: to CSA C22.2 No.56, aluminum and liquid-tight flexible metal.
- .5 Flexible PVC conduit: to CAN/CSA C22.2 No.227.3, ENT.

**2.2                CONDUIT FASTENINGS**

- .1 One hole steel straps to secure surface conduits 53 mm (2") and smaller. Two hole steel straps for conduits larger than 53 mm (2").
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at 1.5 m (5'-0") oc.
- .4 Threaded rods, 6 mm (1/4") diameter, to support suspended channels.

**2.3                CONDUIT FITTINGS**

- .1 EMT fittings shall be set screw style (zinc alloy).
- .2 Flexible metal conduit fittings shall be screw-in type.
- .3 Liquid type flexible metal conduit fittings shall be sealtite type.
- .4 PVC fittings shall be PVC type complete with PVC adaptors at all boxes.
- .5 Rigid conduit and mineral insulated conduit fittings shall be threaded type.
- .6 Coating: same as conduit.

- .7 Factory "ells" where 90° bends are required for 27 mm (1") and larger conduits.
- .8 Where bushings are noted to be provided they must be "screwed" type fastened to a conduit connector. Push-fit or glued in place bushings will NOT be accepted.

## **2.4 FISH CORD**

- .1 Nylon twine.

## **Part 3 Execution**

### **3.1 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/ electrical service rooms and in unfinished areas.
- .3 **Use electrical metallic tubing (EMT) for all branch circuits unless specified otherwise.**
- .4 Use rigid PVC conduit underground and in kitchen areas.
- .5 Use flexible metal conduit for connection to motors in dry areas, connection to recessed fixtures without a prewired outlet box, connection to surface or recessed fixtures, work in movable metal partitions.
- .6 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations and for connections to kitchen equipment.
- .7 Conduits terminating at electrical equipment in sprinklered areas are to be provided with insulated compression style connectors equal to Thomas & Betts Cat. #TC8XXSC or approved equal.
- .8 **Minimum conduit size for branch circuits shall be 21 mm (3/4").** Single drops from ceiling mounted junction boxes down to a light switch or duplex receptacle may be reduced to 16 mm (1/2").
- .9 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .10 Mechanically bend steel conduit over 27 mm (1") diameter.
- .11 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .12 Install fish cord in empty conduits.
- .13 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- .14 Dry conduits out before installing wire.

### **3.2 SURFACE CONDUITS**

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m (5') 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 (3") parallel to steam or hot water lines with minimum of 25 mm (1") at crossovers.
- .7 **Do not fasten surface conduit to roof deck. Provide standoffs or supports as manufactured by Caddy or use Unistrut trapeze fastened to structure.**

### **3.3 CONCEALED CONDUITS**

- .1 Do not install horizontal runs in masonry walls.
- .2 Do not install conduits in terrazzo or concrete toppings.

### **3.4 CONDUITS IN CAST-IN-PLACE CONCRETE**

- .1 Locate to suit reinforcing steel. 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. Use cold mastic between sleeve and conduit.
- .5 Do not place conduits in slabs in which slab thickness is less than 4 times conduit diameter.
- .6 Encase conduits completely in concrete with minimum 27 mm (1") concrete cover.
- .7 Organize conduits in slab to minimize cross-overs.

### **3.5 CONDUITS IN CAST-IN-PLACE SLABS ON GRADE**

- .1 Run conduits 27 mm (1") and larger 300 mm (12") below slab (measured from top of slab to bottom of conduit) and encased in 78 mm (3") sand envelope.

### **3.6 CONDUITS UNDERGROUND**

- .1 Slope conduits to provide drainage.

**END OF SECTION**

**Part 1 General**

**1.1 GENERAL PROVISIONS**

- .1 Conform to the General Provisions of Division 1 and Electrical General Requirements Section.

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with Electrical General Requirements Section.

**Part 2 Products**

**2.1 MATERIALS**

- .1 Rigid PVC ducts must conform to CSA C22.2 No. 211.0, 211.1 and 211.2 (latest edition).
- .2 Ducts and/or cables must be excavated, bedded, reinforced, encased and backfilled as per details on the drawings.

**2.2 DUCT**

- .1 Ducts indicated for encasement in concrete must be type DB-2. Ipex “Super Duct” or approved equal.
- .2 Ducts indicated for direct burial must be type SCEPTER. Ipex “Scepter” rigid PVC duct or approved equal.

**2.3 DUCT FITTINGS**

- .1 Fittings required to provide a complete continuous ductbank installation shall include but not be limited to, couplings, bell end fitting, caps, adapters, base and intermediate spacers.
- .2 Small or large angle couplings will be required where noted on the drawings.
- .3 Expansion joints are to be provided when running ducts in concrete across expansion joints and where exposed on roofs or exterior of buildings.

**Part 3 Execution**

**3.1 BASIC INSTALLATION**

- .1 Excavate trench along route as indicated and at a depth to suit cables and/or ducts as detailed.
- .2 If required, trench is to be pumped to maintain excavation free of water.
- .3 Import granular fill and place in bottom of trench. Compact to provide a firm level base.
- .4 Quantity and arrangement of ducts must be provided according to drawing details.
- .5 When ducts terminate at buildings or precast bases provide bell end fittings.

- .6 When terminating a ductbank for future extension terminate each duct with a coupling. If ducts are encased in concrete set coupling flush with end of concrete.
- .7 Attach ducts to spacers using non-metallic materials.
- .8 Provide concrete as detailed. Pour concrete down sides of ductbank to ensure spaces around and under ducts are filled first.
- .9 Concrete must obtain 50% of its specified strength prior to backfilling.
- .10 Backfilling must be imported granular 'A' material.**
- .11 Backfill must be placed as 150 mm (6") compacted lifts.
- .12 Excess excavated material must be removed from site by this contractor.
- .13 Ensure ducts indicated to be installed along a curb line are installed at least 600 mm (24") from that curb line.

### **3.2 DIRECT BURIAL OF DUCTS**

- .1 After sand bed specified is in place, lay ducts maintaining 75 mm (3") clearance from each side of trench to nearest duct. Do not pull cable into trench.
- .2 Provide offsets for thermal action and minor earth movements. Offset ducts 150 mm (6") for each 60 m (200') run, maintaining minimum duct separation and bending radius requirements.
- .3 Underground cable splices not acceptable.
- .4 Duct separation:
  - .1 Provide separation of ducts in conformance with the details in the Electrical Safety Code.

### **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 multi-conductor control cables reel off in same direction during installation.
- .6 Before pulling cable into ducts and until cables are properly terminated, seal ends of cables with moisture seal tape.
- .7 After installation of cables, seal duct ends with duct sealing compound.

### **3.4 FIELD QUALITY CONTROL**

- .1 Perform tests using qualified personnel. Provide necessary instruments and equipment.
- .2 Check phase rotation and identify each phase conductor of each feeder.

- .3 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 mega ohms.
- .4 Pre-acceptance tests.
  - .1 After installing cable but before terminating, perform insulation resistance test with 1000 V megger on each phase conductor.
- .5 Provide Consultant with list of test results showing location at which each test was made, circuit tested and result of each test.
- .6 Remove and replace entire length of cable if cable fails to meet any of test criteria.
- .7 The Consultant requires a minimum of 48 hours notice to inspect at his discretion the following; ductbank excavation, bedding and duct placement, pouring and/or placement of ductbank encasement.**

**END OF SECTION**



**Part 1            General**

**1.1                GENERAL REQUIREMENTS**

- .1            This analysis is to be performed by an independent, third party firm.**
- .2            The studies must be submitted to the Consultant prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the Consultant may be obtained for a preliminary submittal of sufficient study data to ensure that the selection of device ratings and characteristics will be satisfactory.
- .3            The studies shall include all portions of the electrical distribution system from the normal power source or sources down to and including the smallest adjustable trip circuit breaker in the distribution system, **as well as mechanical unit equipment.** Normal system connections and those which result in maximum fault conditions, shall be adequately covered in the study.
- .4            The firm should be currently involved in high- and low-voltage power system evaluation. The study must be performed, stamped and signed by a registered professional engineer in the Province of Ontario. Credentials of the individual(s) performing the study and background of the firm shall be submitted to the Consultant for approval prior to start of the work. A minimum of five (5) years' experience in power system analysis is required for the individual in charge of the project.
- .5            The firm performing the study should demonstrate capability and experience to provide assistance during start up as required.

**1.2                DATA COLLECTION FOR THE STUDY**

- .1            The Contractor shall provide the required data for preparation of the studies. The Consultant performing the system studies shall furnish the Contractor with a listing of the required data immediately after award of the contract.
- .2            The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to release of the equipment for manufacturing.
- .3            Data collected for the study, including correspondence with local utility, shall be included with study report.

**Part 2            Products**

**2.1                SHORT CIRCUIT AND PROTECTIVE DEVICE EVALUATION AND COORDINATION STUDY**

- .1            The short-circuit study shall be performed with the aid of a digital computer program and shall be in accordance with the latest applicable IEEE and ANSI standards.

- .2 In the short-circuit study, provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, typical calculations, tabulations of calculation quantities and results, conclusions, and recommendations. Calculate short-circuit interrupting and momentary (when applicable) duties for an assumed 3-phase bolted fault at each supply switchgear lineup, unit substation primary and secondary terminals, low-voltage switchgear lineup, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboard, and other significant overcurrent protective device locations throughout the system. Provide a ground fault current study for the same system areas, including the associated zero sequence impedance data. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor fault contribution, short circuit kVA, and symmetrical and asymmetrical fault currents.
- .3 In the protective device coordination study, provide time-current curves graphically indicating the coordination proposed for the system, centered on conventional, full-size, log-log forms. Include with each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered by that particular curve sheet. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings.
- .4 Include on the curve sheets power company relay and fuse characteristics, medium-voltage equipment protective relay and fuse characteristics, low-voltage equipment circuit breaker trip device characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics, and characteristics of other system load protective devices. In addition, include all devices down to the largest branch circuit and largest feeder circuit breaker in each motor control center, and main breaker in branch panelboards. Include all adjustable settings for ground fault protective devices. Include manufacturing tolerance and damage bands in plotted fuse characteristics. Show transformer full load currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and significant symmetrical fault currents. Terminate device characteristic curves at a point reflecting the maximum symmetrical fault current to which the device is exposed.
- .5 Select each primary protective device required for a delta-wye connected transformer so that its characteristic or operating band is within the transformer characteristics, including a point equal to 58 percent of the ANSI withstand point to provide secondary line-to-ground fault protection. Separate transformer primary protective device characteristic curves from associated secondary device characteristics by a 16 percent current margin to provide proper coordination and protection in the event of secondary line-to-line faults. Separate medium-voltage relay characteristic curves from curves for other devices by at least a 0.4-second time margin.
- .6 Include complete fault calculations as specified herein based on contract documents.
- .7 Submit qualifications of individual(s) who will perform the work for approval prior to commencement of the studies. Provide studies in conjunction with equipment submittals to verify equipment ratings required. Submit the study to Consultant for review prior to delivery of the study to the Owner. Make all additions or changes as required by the reviewer.

- .8 Utilize equipment load data for the study obtained by the Contractor from contract documents, including contract addendums issued prior to bid openings.
- .9 Include fault contribution of all motors in the study. Notify the Consultant in writing of circuit protective devices not properly rated for fault conditions.
- .10 Evaluate proper operation of the ground relays in 4-wire distributions with more than one main service circuit breaker, or when generators are provided, and discuss the neutral grounds and ground fault current flows during a neutral to ground fault.
- .11 **Evaluate proper rating of applicable mechanical unit equipment based on available fault at unit connection. Mechanical unit equipment in study shall include packaged assemblies identified as, but not limited to, AHUs, MUAs, DOAS, Chillers, and Cooling Towers.**

## **2.2 STUDY REPORT**

- .1 The results of the power system study shall be summarized in a final report. Submit report in accordance with Electrical General Requirements Section as a shop drawing.
- .2 The report shall include the following sections:
  - .1 Descriptions, purpose, basis, and scope of the study.
  - .2 Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties, and commentary regarding same.
  - .3 **Tabulations of mechanical unit equipment ratings as identified on equipment shop drawings versus calculated short-circuit, and commentary regarding same. Short-circuit calculations for mechanical equipment shall be based on unit MCA with conductor sizes as identified on electrical design drawings and not based on equipment MOCP.**
  - .4 Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
  - .5 Fault current calculations including a definition of terms and guide for interpretation of computer printout.

## **Part 3 Execution**

### **3.1 POWER COMPANY APPROVAL**

- .1 Copies of the final report must be submitted to the power company for their review and approval. Approved copies of the report shall be submitted to the Consultant.

### **3.2 FIELD SETTINGS**

- .1 The Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short-circuit study, protective device evaluation study, and protective device coordination study.

- .2 Necessary field settings of devices and adjustments and minor modifications to equipment to accomplish conformance with the approved short-circuit and protective device coordination study shall be carried out by the Contractor at no additional cost to the Owner.
- .3 At the completion of the project, configure settings and install equipment labels. On company letterhead, the contractor is to prepare a certification letter indicating at minimum:
  - .1 project
  - .2 date
  - .3 device designation
  - .4 certification of correct settings
  - .5 certification of correct device labels
  - .6 digital image of each breaker indicating final settings and placement of labels

### **3.3 SERIES RATING LABELS**

- .1 Provide lamaroid labels where recommended by study. **Labels for series rating with panelboards or equipment shall be indicated on feeder breaker as “SERIES RATING BREAKER” and at the panelboard or equipment as “SERIES RATING EQUIPMENT”. Refer to section 26 24 16.**

### **3.4 ACCEPTABLE TESTING FIRMS**

- .1 MVA Engineering (519) 668-4698
- .2 GT Wood Company Ltd. (905) 272-1696
- .3 Brosz & Associates (905) 472-6660
- .4 K-Tek Electro-services Ltd. (905) 640-2002

**END OF SECTION**

**Part 1            General**

**1.1            SHOP DRAWINGS**

- .1      Submit shop drawings for each system in Conformance with The Electrical General Requirements Section.

**1.2            PRODUCT/MAINTENANCE DATA**

- .1      Submit product/maintenance data for each system for inclusion in maintenance manual conforming to The General Electrical Requirements Section.

**1.3            SCOPE**

- .1      The scope of this Section will include the following systems.
  - .1      Hand dryers.
  - .2      Cable management system.
  - .3      Auxiliary systems rough-in.
  - .4      Security and access control rough-in.
  - .5      Telecommunication network system rough-in.
  - .6      Destratification fans and controls.
  - .7      Public address system rough-in.
  - .8      Line voltage power packs and low voltage occupancy sensors.

**Part 2            Products**

**2.1            HAND DRYERS**

- .1      Hand dryers where noted on the drawings are to be supplied and installed by this Division with the following features:
  - .1      ADA compliant recess mounting.
  - .2      Fixed nozzle with high air velocity.
  - .3      White finish with automatic activation.
  - .4      Rating of 1450 W at 120V
  - .5      Excel Cat. #XL-W-120.
  - .6      Approved alternates:
    - .1      World Dryer
    - .2      Bobrick
    - .3      Comac

## **2.2 CABLE MANAGEMENT SYSTEM**

- .1 The system where noted shall be a continuous, rigid, welded steel wire mesh cable management system with the following features:
  - .1 Permits continuous ventilation of cable and maximum dissipation of heat.
  - .2 Continuous safety edge T-welded wire lip.
  - .3 Welded at all intersections.
  - .4 Straight sections 4" x 12" (100 mm x 300 mm) in configurations noted on the drawings.
  - .5 Constructed of carbon steel wire, ASTM A 510, grade 1008. Wire welded, bent, and surface treated after manufacture.
  - .6 Post fabrication finish of electro-plated zinc galvanizing: ASTM B 633, Type III, SC-1.
  - .7 Fittings: Field fabricated in accordance with manufacturer's instructions from straight sections.
- .2 The support system shall be Cablofil FAS CH hanger.
- .3 The necessary hardware, including splice connectors and support components furnished by manufacturer.
- .4 The product shall be Cablofil Cat. #CF105/300EZ complete with Cat. #FAS P300 CH at intervals as recommended by the manufacturer.
- .5 The manufacturer shall be:
  - .1 Cablofil Inc.  
Local representation by:  
Cablofil  
533 Galway Drive  
Burlington, Ontario  
L7L 2S6  
Ph: 905-681-5380  
Fax: 905-681-2206
- .6 Approved equals:
  - .1 Eaton B-Line FT4x12x10 complete with 12 CTR HGR  
Intralec Electrical Products Ltd.  
1200 Cardiff Blvd.  
Mississauga, Ontario  
L5S 1P6  
Phone: 905-670-0970

## **2.3 AUXILIARY SYSTEMS ROUGH-IN**

- .1 Outlets where noted shall be single gang boxes unless specified otherwise.

- .2 Outlets if unwired are to be provided with blank coverplates to suit related sections of this specification.
- .3 Coordinate final outlet locations, quantities, etc. with respective system vendor and owner's representative.
- .4 Auxiliary systems installation such as CATV, A/V, etc., may be provided by owner's approved vendor as part of cash allowance. Rough-ins only for system devices shall be included in electrical bid price.

## **2.4 SECURITY AND ACCESS CONTROL ROUGH-IN**

- .1 Provide conduit from device and outlet locations to cable management systems as noted on drawings.
- .2 Outlets if unwired are to be provided with blank coverplates to suit related sections of this specification.
- .3 Provide grounding of equipment as noted on drawings.
- .4 Security and access control systems installation shall be by Owner's approved vendor as part of a cash allowance.

## **2.5 TELECOMMUNICATION NETWORK SYSTEM ROUGH-IN**

- .1 Outlets where noted shall be single gang flush mounted in wall or surface raceways.
- .2 Outlets if unwired are to be provided with blank coverplates to suit related sections of this specification.
- .3 Provide a #6 insulated green ground conductor from main service ground to voice equipment backboard located on drawings.
- .4 Telecommunication Network installation shall be by Owner's approved vendor as part of a cash allowance.

## **2.6 DESTRATIFICATION FANS AND CONTROLS**

- .1 Decorative fans indicated as 'DF' on the drawings are to be provided with the following features:
  - .1 Metal construction.
  - .2 Blade, downrod and motor finish as directed by Architect.
  - .3 Down-blowing single direction.
  - .4 1300 (52") diameter blade combination.
  - .5 Minimum 400 mm (16") suspension with ball aligner and canopy.
  - .6 Suitable for 120V/1/60 Hz operation.
  - .7 Manufacturer: Big Ass Fans Cat. #K3127-A2-XX-XX-XX-03-C complete with multi-button wall mounted controller.

## **2.7 PUBLIC ADDRESS SYSTEM ROUGH-IN**

- .1 Provide conduit from device and outlet locations to cable management systems as noted on drawings.

- .2 Outlets if unwired are to be provided with blank coverplates to suit related sections of this specification.
- .3 Provide grounding of equipment as noted on drawings.
- .4 Public address system installation shall be by Owner's approved vendor as part of a cash allowance.

## **2.8 LINE VOLTAGE POWER PACKS AND LOW VOLTAGE OCCUPANCY SENSORS**

- .1 Line voltage power packs and occupancy sensors shall be one manufacturer throughout the project.
- .2 Line Voltage Power packs shall be provided to match the room lighting load, control requirements, and lighting voltage. Power packs shall have the following features:
  - .1 Mount to standard junction box.
  - .2 Simple replacement. It shall be capable to replace the unit without requiring any configuration or set-up.
  - .3 Plenum rated
  - .4 120VAC or 347V, 60HZ operation.
  - .5 Acceptable materials:
    - .1 Sensorswitch Cat. #PP20 Series
    - .2 Legrand Cat. #BZ-250 Series
    - .3 Greengate Cat. #SP15 Series
- .3 Low voltage / analog occupancy sensors shall be complete with the following features:
  - .1 Coverage pattern to suit room ceiling height.
  - .2 Suitable to detect minor and medium motion patterns within rooms less than 2000 sq. ft.
  - .3 Mount to standard junction box.
  - .4 Simple replacement. It shall be capable to replace the unit without requiring any configuration or set-up.
  - .5 Relays shall not be integrated within the occupancy sensor. Relays shall be provided within separate power pack.
  - .6 Acceptable materials
    - .1 Sensorswitch Cat. #CM-PDT Series
    - .2 Legrand Cat. #CI-205
    - .3 Greengate Cat. #OAC-DT-2000

## **Part 3 Execution**

### **3.1 HAND DRYERS**

- .1 Install and connect hand dryers in conformance with manufacturer's recommendations.



- .2 Hand dryers are to be mounted at a height to suit age of expected users. Unless otherwise noted confirm height with manufacturer, owner, Architect, and/or consultant prior to rough-in.
- .3 Once installed this contractor is to caulk the joint between dryer and wall surface with a bead of clear silicone.

### **3.2 CABLE MANAGEMENT SYSTEM**

- .1 Install cable management system at locations indicated on the drawings and in accordance with manufacturer's instructions.
- .2 Support system every 2.4 m (8'-0") unless system is used within a telecommunication room. In that situation support every 1.5 m (5'-0").
- .3 Cut wires in accordance with manufacturer's instructions.
- .4 Cut wires with side action bolt cutters to ensure integrity of galvanic protective layer. Cut using side action bolt cutters (Cablofil Cat. #Coupfil).
- .5 Cut each wire with 1 clean cut to eliminate grinding or touch-up.
- .6 Install cable management system using hardware, splice connectors, support components, and accessories furnished by manufacturer.
- .7 Suspend from structure or intermediate Unistrut channel spanning across the corridor where access to structure is not available due to the concentration of mechanical ductwork and/or piping.
- .8 Ground cable tray with continuous ground per O.E.S.C. and manufacturer instructions. Test to ensure minimum 5 ohms resistance.
- .9 Locate cable management system minimum 9" from EMI sources including but not limited to fluorescent lights, transformers, motors, and power cables.

### **3.3 AUXILIARY SYSTEMS ROUGH-IN**

- .1 Provide backboard for each system use as noted complete with ground buss connection as specified.
- .2 Outlets are to be installed complete with minimum 21 mm (3/4") conduit to accessible ceiling space or as otherwise detailed.
- .3 Conduits terminated into ceiling spaces must be within 3 m (10') of zone conduits when noted.
- .4 Provide insulated bushings on all conduits terminated in ceiling space.
- .5 Ensure specified zone or riser conduits are installed back to equipment backboard.

### **3.4 SECURITY AND ACCESS CONTROL ROUGH-IN**

- .1 Outlets are to be provided for devices with conduit as detailed on drawings.
- .2 Conduits terminated into ceiling spaces must be within 1 m of cable management of tray.

---

**3.5 TELECOMMUNICATION NETWORK SYSTEM ROUGH-IN**

- .1 Install incoming service ducts and terminate as noted.
- .2 Provide backboard as noted complete with ground connection to main service ground.
- .3 Conduits terminated into ceiling spaces must be within 3 m (10') of zone conduits (if applicable).
- .4 Ensure specified zone conduits are installed back to service backboard.
- .5 Outlets are to be installed complete with 25 mm (1") conduit to corridor ceiling space or nearest zone conduit (if applicable).
- .6 Provide insulated bushings on all conduits terminated in ceiling space.
- .7 A 25 mm (1") conduit is to be installed from elevator machine room to voice service backboard.
- .8 Refer to Telecommunication Network Installations Section for additional requirements.

**3.6 DESTRATIFICATION FANS AND CONTROLS**

- .1 Ensure fans and controls are installed in conformance with manufacturer recommendations.
- .2 Demonstrate fan operation at the time of final inspection.
- .3 Contractor is to remove manufacturer's label prior to installation.

**3.7 PUBLIC ADDRESS SYSTEM ROUGH-IN**

- .1 Conduits terminated into ceiling spaces must be within 1 m (10') of cable management tray.
- .2 Outlets are to be installed complete with 25 mm (1") conduit to corridor ceiling space or nearest cable management tray.
- .3 Provide insulated bushings on all conduits terminated in ceiling space.
- .4 Electrical contractor shall obtain speaker back boxes from School Board vendor for installation into ceiling tiles, block walls, etc.

**3.8 LINE VOLTAGE POWER PACKS AND LOW VOLTAGE OCCUPANCY SENSORS**

- .1 Install power packs in accessible maintenance areas.
- .2 Provide access doors if power packs are installed above drywall ceilings.
- .3 Install sensors in gym where noted on plan at mid height of wall.
- .4 Sensors installed in areas of high abuse shall be complete with wire guards.
- .5 It shall be the contractor's responsibility to locate and aim sensors in the correct location required for complete and proper coverage within the range of coverage as per the manufacturer's recommendations. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the respective rooms.

- 
- .6 It is the contractor's responsibility to arrange a pre-installation meeting with the manufacturer's factory authorized representative, at the facility, to verify placement to sensors and installation criteria.
  - .7 The contractor shall also provide the on-site training necessary to familiarize the owner's personnel with the operation, use, adjustment and problem solving diagnosis of the occupancy sensing devices systems.
  - .8 Upon completion of the installation, the system shall be completely commissioned by the manufacturer's factory authorized technician who will verify all adjustments and sensor placement to ensure a trouble-free occupancy-based lighting control. Submit commissioning report with closeout documents.
  - .9 **All lighting controls shall be provided with functional testing and documentation conforming to Ashrae 90.1, latest adoption. This cost shall be included in the Tender Price.**

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 Dry type transformers must conform to CSA C22.2 No.47 and C9 (latest edition).
- .2 **Dry type transformers must conform to CSA C802 (latest edition).**
- .3 **Dry type transformers must be in accordance with Ontario Green Energy Act 2018 (NRCan 2018) DOE 2016.**

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with Electrical General Requirements Section.

**Part 2 Products**

**2.1 TRANSFORMERS**

- .1 Transformers to be of one manufacturer throughout project.
- .2 Ratings and characteristics shall be as indicated on riser diagrams.
- .3 Aluminum winding.
- .4 Transformers are to be ventilated dry type style with 4-2½% taps (2 F.C.B.N. and 2 F.C.A.N.)
- .5 Maximum permissible sound levels shall be as follows:

Transformer Rating (KVA)	Sound Level (dBA)
≤50	45
51 to 150	50
151 to 300	55
301 to 500	60

- .6 **All transformers with a K factor of 4 or above must be electro-static shielded.**
- .7 **Transformers with a K-factor of 4 or above must include a secondary neutral bus that is sized at twice the rated secondary phase current.**
- .8 Transformer enclosure shall be EEMAC/NEMA 3R ventilated complete with removable front panel.
- .9 Provide vibration isolators equal to Korfund R series, Mason ND-B, or approved equal. "Colour" of vibration isolators shall be based on weight of transformers.

Transformer Weight (lbs)	Approximate Rating	Colour (Korfund)
540	15 – 75 kVA	Blue (RD2)
680	112.5 kVA	Black (RD2)
960	150 kVA	Red (RD2)
1,520	300 kVA	Green (RD2)
2,200	500 kVA	Gray (RD3)

## 2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Electrical General Requirements Section.
- .2 Label must indicate:
  - .1 transformer “tag” as per riser diagram
  - .2 primary and secondary voltage and phase.

## 2.3 ACCEPTABLE MANUFACTURERS:

- .1 Acceptable manufacturers are as follows:
  - .1 Hammond
  - .2 Rex
  - .3 Delta
  - .4 Acme
  - .5 Bemag

## Part 3 Execution

### 3.1 INSTALLATION

- .1 Primary and secondary feeders are to be connected using flexible conduit.
- .2 Transformers with a rating up to and including 75 KVA are permitted to be wall mounted provided mounting method is a suitably sized angle iron frame secured to structure (i.e. masonry wall, steel columns, etc. NOT metal siding).
- .3 The above rating of transformers may also be suspended from **structure only** on a unistrut trapeze as detailed.
- .4 Transformers above 75 KVA must be floor mounted.
- .5 Floor mounted transformers are to be mounted/secured to a concrete pad suitably sized to suit the transformer. This pad is the responsibility of this contractor and must be provided in conformance with the standard of Division 1 specifications for poured in place concrete.
- .6 All transformers must be mounted on vibration isolators selected based on transformer weight.

- .7 Ensure adequate clearance around transformer for ventilation as per the Electrical Safety Code.
- .8 Loosen isolation pad bolts until no compression is visible.
- .9 Install transformers in level upright position.
- .10 Remove shipping supports only after transformer is installed and just before putting into service.
- .11 Make primary and secondary connections in accordance with wiring diagram.
- .12 Energize transformers after installation is complete.

**END OF SECTION**

**Part 1            General**

**1.1            PRODUCT DATA**

- .1      Submit product data in accordance with Electrical General Requirements Section.
- .2      Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

**Part 2            Products**

**2.1            PANELBOARDS**

- .1      Panel boards must conform to CSA C22.2 No. 29 (latest edition).
- .2      Panelboards: product of one manufacturer.
- .3      Install circuit breakers in panelboards before shipment.
- .4      In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand. **Series rating is acceptable – submit information with shop drawings. Provide lamicaid label on feeder breaker. Lamicaid label to state "Series Rating Breaker." Lamicaid label to be size 2.**
- .5      Bus and breakers must be rated for (symmetrical) interrupting capacity as indicated.
- .6      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.
- .7      Panelboard mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .8      Two keys for each panelboard and key panelboards alike.
- .9      Aluminum bus with neutral of same ampere rating as mains.
- .10     Mains must be suitable for bolt-on breakers. Provide main (if applicable) and branch breakers as bolt-on style.
- .11     Trim with concealed front bolts and hinges.
- .12     Trim and door finish must be baked grey enamel.
- .13     All panels regardless of voltage and amperage must be provided with a lockable door.
- .14     Branch circuit panelboards (250 AMP or smaller) must be one of the following:
  - .1      Eaton Cat # POW-R-LINE-C PRL-1 or PRL-2
  - .2      Schneider Electric Cat # NQ Series for up to 240V or NF Series for up to 600V
  - .3      Siemens Cat #Sentron P1 Series

- .15 Branch circuit panelboards indicated to be complete with an external surge protective device shall include a suitably sized branch circuit breaker for the surge protective device as noted on panel schedule, and per surge protective device manufacturer recommendations. Surge protective device shall be provided as specified in section 26 43 13, unless noted otherwise.
- .16 Power distribution circuit breaker panelboards (400 AMP or larger) must be one of the following:
  - .1 Eaton CAT# POW-R-Line-C PRL-3A or PRL-4A
  - .2 Schneider Electric CAT# I-Line Series (Bolt-On)
  - .3 Siemens CAT# P2 Series (up to 600A mains and maximum 100A-3P branch breakers)
  - .4 Siemens CAT# S5 Series (up to 1200A mains with branch breakers above 100A-3P)

## **2.2 BREAKERS**

- .1 Breakers: to Moulded Case Circuit Breakers Section.
- .2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
- .3 Main breaker (as specified) must be separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
- .4 Lock-on devices for fire alarm, stairway, exit and night light circuits.

## **2.3 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Electrical General Requirements Section.
- .2 Nameplate for each panelboard size 4 engraved description as indicated. In finished areas install label on inside of panel, and in service areas install label on exterior of panel.
- .3 Nameplate for each circuit in distribution panelboards size 2 engraved "name of load" as indicated.
- .4 Complete circuit directory with typewritten legend showing location of each circuit.  
**Include a copy of the directories in the maintenance manuals.**

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.



- .2 Install surface mounted panelboards on plywood backboards. Where practical, group panelboards on common backboard. Plywood shall be 21 mm (3/4") fire rated or painted with intumescent fire block paint having a minimum of 1h rating, unless noted otherwise.
- .3 Mount panelboards to height specified in Electrical General Requirements Section or as indicated.
- .4 Connect loads to circuits.
- .5 Connect neutral conductors to common neutral bus.
- .6 Mount external surge protective devices as close as possible to panelboard and associated branch breaker to minimize lead lengths and per manufacturers recommendations. Provide modified panel trim for flush mount applications as required to suit.
- .7 Install series rating lamicoids adjacent to all breakers utilized to achieve series ratings.

**END OF SECTION**

**Part 1 General**

**1.1 PRODUCT DATA**

- .1 Submit product data in accordance with Electrical General Requirements Section.

**Part 2 Products**

**2.1 BREAKERS GENERAL**

- .1 Moulded case circuit breakers must conform to CSA C22.1 No.5.1-M91 (latest edition.)
- .2 Bolt-on moulded case circuit breaker quick-make, quick-break type, for manual and automatic operation.
- .3 Common-trip breakers: with single handle for multi-pole applications.
- .4 Unless otherwise indicated 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.
- .5 Moulded case circuit breakers 250 Amps and above are to operate by means of a solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long time, short time, instantaneous tripping for phase and ground fault short circuit protection (if indicated or applicable by the Electrical Safety Code versus the breaker amperage). Unless otherwise specified, complete system selective co-ordination shall be provided by the individually adjustable time/current curve shaping elements as following:
  - .1 Breakers shall have fixed rating plug determining breaker continuous current rating.
  - .2 All breakers shall have adjustable long delay pickup and time, L.
  - .3 All breakers shall have individual adjustments for short delay pickup and time, S; including I2t settings in time adjustment.
  - .4 Breakers shall have adjustable instantaneous pickup, I; that if required by co-ordination study can be turned off, (I).
  - .5 If required by Electrical Safety Code breakers shall have individually adjustable ground fault current pick-up and time, G; including I2t settings in time adjustment.
  - .6 Unless otherwise specified, for the low voltage systems provide an electronic trip unit as specified above for the following moulded case circuit breakers:
    - .1 Mains or ties in main switchboard: LS trip unit with fixed instantaneous over-ride exceeding maximum value of fault at the point of installation.
    - .2 Feeders exceeding 250A trip setting: LS trip unit with fixed instantaneous over-ride exceeding maximum value of fault at downstream panelboard.

**Part 3            Execution**

**3.1                INSTALLATION**

- .1        Install circuit breakers as indicated complete with all necessary mounting hardware and filler panels if necessary.
- .2        Provide lamicoid labels for series rating breakers. Lamicoid label to state "Series Rating Breaker." Lamicoid to be size 2.

**END OF SECTION**

**Part 1            General**

**1.1            SHOP DRAWINGS AND PRODUCT DATA**

- .1        Submit shop drawings and product data in accordance with Electrical General Requirements Section.

**Part 2            Products**

**2.1            SWITCHES**

- .1        Line Voltage Wall Switches
  - .1        AC switches must conform to CSA C22.2 No. 111 (latest edition).
  - .2        AC switches with following features:
    - .1        Terminal holes approved for No. 10 AWG wire.
    - .2        Silver alloy contacts.
    - .3        Urea or melamine molding for parts subject to carbon tracking.
    - .4        Suitable for back and side wiring.
    - .5        Toggle style (Rocker style) (architect to select colour).
  - .3        Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
  - .4        AC Switches of one manufacturer throughout project.
  - .5        Provide two keys per keyed switch.
  - .6        Occupancy sensor switches shall be dual technology style (PIR and Ultrasonic) where noted on the drawings.
  - .7        Acceptable Materials:
    - .1        Single Pole : Hubbell Cat #HBL1201
    - .2        Three Way: Hubbell Cat. #HBL1203
    - .3        Four Way: Hubbell Cat. #HBL1204
    - .4        Keyed: Hubbell Cat. #HBL1221 Series
      - .1        Keys: Hubbell Cat. #HBL1209
    - .5        Motor Rated: Hubbell Cat. #HBL1221PL
    - .6        Single Pole (Decora): Hubbell Cat #HBL2101
    - .7        Three Way (Decora): Hubbell Cat #HBL2103
    - .8        Four Way (Decora): Hubbell Cat. #HBL2124
    - .9        Single Relay Occupancy Sensor includes:
      - .1        Legrand Cat. #DW-100
      - .2        Greengate Cat. #ONW-D-1001
      - .3        Sensorswitch Cat. #WSXA Series

- .10 Dual Relay Occupancy Sensor includes:
  - .1 Legrand Cat. #DW-200
  - .2 Greengate Cat. #ONW/VNW-D-1001-DMV-N
  - .3 Sensorswitch Cat. #WSXA Series
- .8 Acceptable toggle switch alternate manufacturers include:
  - .1 Pass & Seymour
  - .2 Leviton.

## 2.2 RECEPTACLES

- .1 Receptacles, plugs, and other similar wiring devices must conform to CSA 22.2 No 42 (latest edition).
- .2 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, with following features (20A where noted):
  - .1 Urea molded housing (Colour by architect).
  - .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.
- .3 Other receptacles with ampacity and voltage as indicated.
- .4 Receptacles of one manufacturer throughout project.
- .5 Acceptable materials:
  - .1 Standard Devices
    - .1 Tamper resistant receptacle: Hubbell Cat # BR15TR
    - .2 Tamper resistant T-slot receptacle: Hubbell Cat. #BR20TR
    - .3 Automatically Controlled Receptacles (Green): Hubbell Cat. #BR15C2GN(Green)
  - .2 Above 20A
    - .1 Dryer receptacle: Hubbell Cat # HBL9430A
    - .2 Range receptacle: Hubbell Cat # HBL9450A
  - .3 Tamper resistant
    - .1 Tamper resistant ground fault protected receptacle: Hubbell Cat. #GFTR15
    - .2 Tamper resistant ground fault protected T-slot receptacle: Hubbell Cat. #GFTR20
    - .3 Tamper resistant duplex receptacle complete with dual USB ports: Hubbell Cat. #USB15XXX
    - .4 Automatically Controlled Tamper Resistant Receptacles (Green): Hubbell Cat. #BR15C2GNTR

.6 Acceptable alternate manufacturers include:

- .1 Pass & Seymour
- .2 Leviton

## **2.3 COVER PLATES**

- .1 Cover plates from one manufacturer throughout project.
- .2 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .3 Stainless steel, brushed, 1 mm (1/32") thick cover plates for wiring devices mounted in flush-mounted outlet box.
- .4 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .5 Weatherproof cover plates complete with gaskets and "heavy-duty in use" covers in conformance with the Electrical Safety Authority. Provide product equal to Intermatic Cat. #WP5100C.
- .6 Where noted on plans for exterior weatherproof GFCI receptacles at grade, provide extra-duty single gang horizontal die cast receptacle covers. NEMA 3R rated complete with lockable hasp and reinforced hinge. Suitable for use with 12-gauge cord sets. Intermatic Cat. # WP1010HMXD or equal.
- .7 Provide p-touch labels on cover plates for all receptacles. Labels shall include source panel and branch circuit, including switch leg indicator as applicable for automatically controlled receptacles.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Switches:
  - .1 Install single throw switches with handle in "UP" position when switch closed.
  - .2 Install switches in gang type outlet box when more than one switch is required in one location.
  - .3 Mount toggle switches at height specified in Electrical General Requirements Section or 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 specified in Electrical General Requirements Section or as indicated.
  - .3 Where split receptacle has one portion switched mount vertically and switch upper portion.

- 
- .3 Occupancy sensors:
    - .1 Occupancy sensors shall be set to 5 minutes “delay to off” unless otherwise noted.
  - .4 Occupancy sensors and dimmers:
    - .1 Switches with occupancy sensors and dimmers shall be programmed as follows:
      - .1 5 minutes “delay to off” unless otherwise noted.
      - .2 “Auto on” to 50% dimming level.
  - .5 Cover plates:
    - .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
    - .2 Install suitable common cover plates where wiring devices are grouped.
    - .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.
  - .6 Dimmer:
    - .1 Dimming Switches
      - .1 Mount devices at height as specified in Electrical General Requirements Section.
      - .2 Install in upright position as per manufacturer’s installation instructions.
      - .3 Provide class II 0-10V control wiring from 0-10V dimming switch to each fixture driver in 21mmC.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 Canadian Standards Association (CSA)
  - .1 CSA C22.2 No.248.12/94, Low Voltage Fuses Part 12: Class R (Bi-National Standard with, UL 248-12 (1st Edition).
  - .2 CSA C22.2 No. 106-M92 (latest edition).

**1.2            MAINTENANCE MATERIAL**

- .1 Three spare fuses of each type and size installed.

**1.3            DELIVERY AND STORAGE**

- .1 Ship fuses in original containers.
- .2 Store fuses in original containers in moisture free location.

**Part 2            Products**

**2.1            FUSES GENERAL**

- .1 Fuses: product of one manufacturer for entire project.
- .2 Fuses specified below must conform to CSA C22.2 No. 106 (latest edition). Fuses conforming to standard C22.2 No. 106-1953 will be rejected.
- .3 Fuses must provide a fully co-ordinated system for both overload and fault conditions.

**2.2            FUSE TYPES**

- .1 Class J fuses (formerly HRCI- J).
  - .1 Time delay, capable of carrying 500% of its rated current for 10 s minimum.
  - .2 Fast acting as noted.
- .2 Class R fuses (formerly HRCI- R). For UL Class RK1 fuses, peak let-through current and  $I^2t$  values not to exceed limits of UL 198E-1982, table 10.2.

**2.3            ACCEPTABLE PRODUCTS**

- .1 Motor Protection:
  - 1-600 A: Mersen Type AJT
- .2 Other acceptable manufacturers:
  - .1 GEC
  - .2 Little Fuse



**Part 3            Execution**

**3.1                INSTALLATION**

- .1        Install fuses in mounting devices immediately before energizing circuit.
- .2        Ensure correct fuses fitted to physically matched mounting devices.
  - .1        Install Class R rejection clips for HRCI-R fuses.
- .3        Ensure correct fuses fitted to assigned electrical circuit.

**END OF SECTION**

**Part 1 General**

**1.1 PRODUCT DATA**

- .1 Submit product data in accordance with Electrical General Requirements Section.

**Part 2 Products**

**2.1 DISCONNECT SWITCHES**

- .1 Enclosed manual air break switches must conform to CSA C22.1 No.4 (latest edition).  
.2 Fuseholder assemblies must conform to CSA C22.2 No.39 (latest edition).  
.3 Fusible, and/or non-fusible, horsepower rated disconnect switches, size as indicated.  
.4 Provision for padlocking in off switch position by three locks.  
.5 Mechanically interlocked door to prevent opening when handle in ON position.  
.6 Fuses: size as indicated, to Fuses - Low Voltage Section.  
.7 Fuseholders: relocatable and suitable without adaptors, for type and size of fuse indicated.  
.8 Quick-make, quick-break action.  
.9 ON-OFF switch position indication on switch enclosure cover.

**2.2 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Electrical General Requirements Section.  
.2 Indicate name of load controlled on size 4 nameplate.

**2.3 ACCEPTABLE MANUFACTURERS**

<u>Manufacturer</u>	<u>General Purpose</u>	<u>Weather Proof</u>
Eaton	IHD Series	3HD Series
Schneider Electric	Type A Series	Type R Series
Siemens	ID Series	NFR/FR Series

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install disconnect switches complete with fuses if applicable.

**END OF SECTION**

**Part 1            General**

**1.1            SHOP DRAWINGS AND PRODUCT DATA**

- .1      Submit shop drawings in accordance with Electrical General Requirements Section.
- .2      Indicate:
  - .1      Mounting method and dimensions.
  - .2      Starter/contactor size and type.
  - .3      Layout of identified internal and front panel components.
  - .4      Enclosure types.
  - .5      Wiring diagram for each type of starter.
  - .6      Interconnection diagrams.

**1.2            OPERATION AND MAINTENANCE DATA**

- .1      Provide operation and maintenance data for incorporation into manual specified in Electrical General Requirements Section.
- .2      Include operation and maintenance data for each type and style of starter/contactor.

**1.3            MAINTENANCE MATERIALS**

- .1      Provide maintenance materials in accordance with Electrical General Requirements Section.
- .2      Provide listed spare parts for each different size and type of starter:
  - .1      1 operating coil.
  - .2      3 fuses.
  - .3      10% indicating lamp bulbs used.

**Part 2           Products**

**2.1            MATERIALS**

- .1      Starters: must conform to CSAC22.2 No. 14 (latest edition) and EEMAC E14-1.
- .2      Control transformers must conform to CSAC22.2 No. 66 (latest edition).
- .3      Auto-transformers must conform to CSAC22.2 No 47 (latest edition).
- .4      Contactors must conform to CSA C22.2 No. 14 (latest edition).
- .5      Half size starters will not be accepted. NEMA and IEC rated starters are acceptable.

**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.
- .3 Toggle switch: standard duty labeled "on"/"off".
- .4 Indicating light: standard duty type and red colour.
- .5 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 three padlocks.
  - .2 Independent locking of enclosure door.
  - .3 Provision for preventing switching to "ON" position while enclosure door open.
- .3 Accessories:
  - .1 Pushbuttons Selector switches standard duty labeled as indicated.
  - .2 Indicating lights: standard duty type and color as indicated.
  - .3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.
  - .4 1 red pilot light for "stop" or "off" and 1 green light for "start" or "on".

## **2.4 CONTROL TRANSFORMER**

- .1 Single phase, dry type, control transformer with primary voltage as indicated and secondary voltage to suit remote control device, complete with secondary fuse, installed in with starter as indicated.
- .2 Size control transformer for control circuit load plus 20% spare capacity.

## **2.5 CONTACTORS**

- .1 Electrically held and controlled by pilot devices as indicated and rated for type of load controlled.
- .2 Complete with two normally open and two normally closed auxiliary contacts unless indicated otherwise.
- .3 Mount in CSA Enclosure 1 unless otherwise indicated.
- .4 Include following options in cover:
  - .1 Red indicating lamp.
  - .2 Hand - Off - Auto selector switch.

- .5 Control transformer: mounted in contactor enclosure.
- .6 Contactors must be definite purpose.

## **2.6 FINISHES**

- .1 Apply finishes to enclosure in accordance with Electrical General Requirements Section.

## **2.7 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Electrical General Requirements Section.
- .2 Manual starter designation label: black plate, white letters, size 1, engraved as indicated.
- .3 Magnetic starter designation label: black plate, white letters, size 2, engraved as indicated.
- .4 Contactor designation label:  
black plate, white letters, size 4, indicating name of load controlled.

## **2.8 ACCEPTABLE MANUFACTURERS**

- .1 The acceptable manufacturers are as follows:
  - .1 Allen Bradley
  - .2 Eaton
  - .3 Siemens
  - .4 Group Schneider
  - .5 Klockner Moeller

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install starters, connect power and control as indicated.
- .2 Ensure correct fuses and overload devices elements installed.

### **3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Electrical General Requirements Section.
- .2 Operate switches, 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.
- .5 Install contactors and connect auxiliary control devices.

**END OF SECTION**

**Part 1            General**

**1.1            SUMMARY**

- .1        The specifications in this section describe the electrical and mechanical requirements for a protection system provided by high-energy transient voltage surge suppressors. The specified system shall provide effective, high-energy surge current diversion and be suitable for application in ANSI/IEEE C62.4.1.1 Category A, B and C environments (as tested by ANSI/IEEE C62).

**1.2            STANDARDS**

- .1        The specified system shall be designed, manufactured, tested and installed in compliance with the following codes and standards:
  - .1            Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11, C62.41, C62.45)
  - .2            American National Standards Institute
  - .3            National Electrical Manufacturer Association (NEMA LS-1 1992 Peak Current Testing)
  - .4            Electrical and Electronic Mfg. Association of Canada (EEMAC)
  - .5            National Fire Protection Association (NFPA 75 and 780)
  - .6            MIL Standard 220A Method of Insertion Loss Measurement
  - .7            Ontario Electrical Code
  - .8            Underwriters Laboratories UL 1283 and UL 1449 (latest edition)
  - .9            Canadian Standards (CUL)

**1.3            ENVIRONMENTAL REQUIREMENTS**

- .1        The operating temperature range shall be -40° to 70° C (-40° to 160° F).
- .2        No appreciable magnetic fields shall be generated.

**1.4            SUBMITTALS**

- .1        Product Data: Provide catalog sheets showing voltage, physical size, IEEE let through voltage for each waveform listed, UL1449 latest revision, latest edition, suppressed voltage ratings, dimensions showing construction, lifting and support points, enclosure details, per mode and per phase peak surge current, modes of discrete suppression circuitry, warranty period and replacement terms, conductor size, conductor type and lead length.
- .2        Submit product data for all components and accessories per section 26 01 16 'Electrical General Requirements'.

- .3 Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product. Indicate maximum size of circuit breaker or fuse to be connected for each unit.
- .4 List and detail all protection systems such as fuses, disconnecting means and protective features.
- .5 Provide verification that the SPD device complies with the required UL1449 latest edition, latest revision, and CSA approvals.
- .6 Provide actual let through voltage test data in the form of oscillograph results for the ANSI/IEEE C62.41 Category C3 & C1 (combination wave) and A1 (ringwave) tested in accordance with ANSI/IEEE C62.45.
- .7 Provide spectrum analysis of each unit based on MIL-STD-220A test procedures between 10 kHz and 100 kHz verifying the devices noise attenuation equals or exceeds 40 dB at 100 kHz.
- .8 Provide test report from a recognized independent testing laboratory verifying the suppressor components can survive published surge current rating on a per mode basis using the IEEE C 62.41, 8x20 microsecond current wave. Test data must be on a complete SPD with internal fusing in place. Test data on an individual module is not acceptable.

## **1.5 QUALITY ASSURANCE AND WARRANTY**

- .1 The panel mounted SPD and supporting components shall be guaranteed by the manufacturer to be free of defects in material and workmanship for a period of 30 years from the date of substantial completion of service and activation of the system to which the suppressor is attached. Additionally, during the applicable warranty period, any SPD which fails due to any electrical anomaly, including lightning, shall be repaired or replaced by the manufacturer without charge. Special or optional warranties in excess of the unit's standard warranty for purposes of this bid are not acceptable.
- .2 The warranty must specifically provide for unlimited free replacements of the SPD in the event of failure caused by the effects of lightning and all other electrical anomalies. The warranty shall cover the entire device, not just various components, such as modules only. Special warranties for the purpose of this bid are not allowed.
- .3 If the SPD units supplied do not meet the specifications as written, contractor will remove units and re-install approved SPD units to the satisfaction of the consultant. Contractor will be responsible for any and all costs associated with re-installation.

## **Part 2 Products**

### **2.1 PERFORMANCE**

- .1 The SPD shall be listed by ETL, UL, or other nationally recognized test laboratory to UL's 1283 and UL's 1449 standards (latest edition), and not merely the components or modules. All SPD's shall be Type 1 for use in Type 1 and Type 2 locations.

- .2 The SPD shall protect all modes L-G, L-N, L-L, and N-G, have discrete suppression circuitry in L-G, L-N and N-G, and have bidirectional, positive and negative impulse protection. Line-to-neutral-to-ground protection is not acceptable where line-to-ground is specified and accordingly reduced mode units with suppression circuitry built into only 4 modes are not acceptable. In delta systems, line-to-ground-to-line protection is not acceptable where line-to-line is specified.
- .3 Obtain all surge suppression devices through one source from a single manufacturer.
- .4 The maximum continuous operating voltage (MCOV) of all components shall not be less than 125% for a 120V system and 120% for 208 systems, and 115% for 347 and 600V systems.
- .5 All SPD's shall be equipped with a comprehensive monitoring system which shall include a visual LCD panel display providing information on unit status and phase loss/protection loss.
- .6 Each design configuration shall have the maximum single pulse surge current capacity per mode verified through testing at an independent, nationally recognized test laboratory. The manufacturer must submit a test report on a unit which was tested with internal over current fusing in place. The test shall include a UL1449 Second Edition surge defined as a 1.2 X 50  $\mu$ sec 6000V open circuit voltage waveform and an 8 X 20  $\mu$ sec 500A short circuit current waveform to benchmark the unit's suppression voltage, followed by a single pulse surge of maximum rated surge current magnitude with an approximated 8 X 20  $\mu$ sec waveform. To complete the test, another UL1449 surge shall be applied to verify the unit's survival. Compliance is achieved if the suppression voltage found from the two UL1449 surges does not vary by more than +10%. Test data on an individual module is not acceptable.
- .7 SPD manufacturer shall be Total Protection Solutions Canada, as provided by Innosys Power Inc. and represented by Medgar LCI (Contact Scott McGregor, Ph: 519-500-7120).

## **2.2 DISTRIBUTION PANEL PROTECTION**

- .1 SPD(s) for this location shall be as indicated on project drawings. SPD shall be separate from panel board. Integral SPD shall not be acceptable. SPD's shall be certified to UL 1283 and UL1449 (latest edition). Type 1 for use in Type 1 and Type 2 locations.
- .2 Distribution Panels shall be protected by a Total Protection Solutions panel mounted SPD, model TK-ST160-600NN-FL for 600 (3W+G) volt panels, model TK-ST160-3Y600-FL for 347/600 (4W+G) volt panels and model TK-ST160-3Y208-FL for 120/208 (4W+G) volt panels.



- .3 The manufacturer shall provide written specifications showing let-through voltage of the unit with six inches of lead length (at the module or at the lug data is not acceptable as it does not represent true "as installed" performance) pursuant to ANSI/IEEE C62.41 and C62.45, 2002, categories B3/C1 and C3 bi-wave, 90 degree phase angle, positive polarity, measurements in peak voltage from the zero reference, all dynamic tests except N-G, and UL suppressed voltage ratings, all of which shall be no higher than:

ANSI/IEEE C62.41-1991 Measured Limiting Voltage

B3/C1 Impulse (6kV, 3kA)

Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/208 (3Y208)	502V	627V	864V	568V
347/600 (3Y600)	1090V	1144V	2017V	1155V

C3 Impulse (20kV, 10kA)

Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/208 (3Y208)	907V	1173V	1267V	1090V
347/600 (3Y600)	1537V	1707V	2470V	1800V

UL Voltage Protection Ratings

Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/208 (3Y208)	800V	800V	1200V	800V
347/600 (3Y600)	1500V	1500V	2500V	1500V

- .4 The unit shall have a peak surge current of no less than 160kA/phase, 80kA/mode, 8 X 20 us waveform, single impulse, verified by third party test reports.

.5 Internal Fusing - Over current Protection

- .1 Each Metal Oxide Varistor, or other primary suppression component, shall be individually fused for safety and performance to allow the SPD to withstand the full rated single pulse peak surge capacity per mode without the operation or failure of the fuses. Over current fusing that limits the listed peak surge current of the SPD is not acceptable. Replaceable cartridge type per phase or per mode over current fusing is not acceptable where there is more than one MOV per mode.
- .2 For arc quenching capability, minimization of smoke and contaminants in the event of a failure, and to ensure the safest possible design, all surge components, current carrying paths and fusing shall be packed in fuse grade silica sand.
- .3 Fusing shall be present in every mode, including Neutral-to-Ground.
- .4 The fusing shall be capable of interrupting up to a 200kA symmetrical fault current with 600VAC applied.

- .6 The suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability, and shall have at minimum a Nema 4 steel enclosure.
- .7 The SPD shall have an internal audible alarm with mute on front cover.

### 2.3 SUBPANEL AND LIGHTING PANEL PROTECTION

- .1 SPD(s) for this location shall be as indicated on project drawings. SPD shall be separate from panel board. Integral SPD shall not be acceptable. SPDs shall be certified to UL1283 and UL1449 (latest edition). Type 1 for use in Type 1 and Type 2 locations.
- .2 Subpanels and lighting panels shall be protected by a panel mounted SPD, TK-LP120-3Y208-L-F for 120/208 (4W+G) volt recessed panels and TK-TT2-065-3Y208-FL for surface mounted panels.
- .3 The manufacturer shall provide written specifications showing let-through voltage of the unit with six inches of lead length (at the module or at the lug data is not acceptable as it does not represent true "as installed" performance) pursuant to ANSI/IEEE C62.41 and C62.45, 2002, categories A1 & A3 ring wave, 180 degree phase angle, category B3 Ringwave, and UL suppressed voltage ratings, 90 degree phase angle, positive polarity, measurements in peak voltage from the zero reference, all dynamic tests except N-G, which shall be no higher than:

#### ANSI/IEEE C62.41-1991 Measured Limiting Voltage

A1 Ring Wave (2kV, 67A)	Tested at 180 degree phase angle			
Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/208 (3Y208)	29V	46V	39V	40V

A3 Ring Wave (6kV, 200A)	Tested at 180 degree phase angle			
Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/208 (3Y208)	56V	61V	88V	112V

B3 Ring Wave (6kV, 500A)	Tested at 90 degree phase angle			
Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/208 (3Y208)	437V	592V	612V	324V

#### UL Voltage Protection Ratings

Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/208 (3Y208)	700V	700V	1000V	700V

- .4 The unit shall have a peak surge current of no less than 120kA/phase, 60kA/mode, 8 X 20 us waveform, single impulse, verified by third party test reports.

- .5 Internal Fusing - Over current Protection
  - .1 Each Metal Oxide Varistor, or other primary suppression component, shall be individually fused for safety and performance to allow the SPD to withstand the full rated single pulse peak surge capacity per mode without the operation or failure of the fuses. Over current fusing that limits the listed peak surge current of the SPD is not acceptable. Replaceable cartridge type per phase or per mode over current fusing is not acceptable where there is more than one MOV per mode.
  - .2 For arc quenching capability, minimization of smoke and contaminants in the event of a failure, and to ensure the safest possible design, all surge components, current carrying paths and fusing shall be packed in fuse grade silica sand.
  - .3 Fusing shall be present in every mode, including Neutral-to-Ground.
  - .4 The fusing shall be capable of interrupting up to a 200kA symmetrical fault current with 600VAC applied.
- .6 The SPD shall be capable of attenuating internally generated ringing type transients and noise, and shall have an enhanced transient filter supported by a specification sheet which lists the IEEE A1 Ring Wave let-through levels no higher than those set forth above.
- .7 Due to space limitations, the enclosure shall not exceed 4.0" D x 4.0" W x 10.3" H to allow close-to-the load installation on flush mount panels and between adjacent panel board. For recessed panels, a flush mount cover plate shall be provided with each unit along with a flush mount accessory kit Cat. #LP-FMP.
- .8 The suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability, and shall have at minimum a Nema 1 steel enclosure.
- .9 The SPD shall have an internal audible alarm with mute on front cover.

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 Install the SPD's with the conductors as short and straight as practically possible.
- .2 Follow the SPD manufacturer's recommended installation practice as outlined in the equipment installation manual. The electrical contractor shall ensure that all neutral conductors are bonded to the system ground at the service entrance or the serving isolation transformer prior to installation of the associated SPD.
- .3 Distribution and branch panel shall be installed on 30 amp dedicated circuit breakers, or, where indicated, shall be wired directly to the main lugs or feed through lugs, or wired directly to the bus bars.
- .4 The installing contractor shall comply with all applicable codes.
- .5 SPD units shall be wired such that connection cable lead lengths are minimized. SPD manufacturer to advise installing contractor on required locations of low impedance cables (LICs).

- .6      SPD manufacturer shall include in tender for pre-installation visit to the job site to confirm recommended installation methods. Indicate provision for this visit on shop drawing submission.**
- .7      The entire SPD installation must be inspected by an authorized manufacturer's representative and supply certificate of completion. This cost shall be included in the tender price. Indicate provision for this inspection on shop drawing submission.**

**END OF SECTION**

---

**Part 1                    General**

**1.1                    REFERENCES**

- .1 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)
  - .1 ANSI/IEEE C62.41- 1991, Recommended Practices for Surge Voltages in Low-Voltage AC Power Circuits.
- .2 American Society for Testing and Materials (ASTM)
  - .1 ASTM F1137- 88 (1993), Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.
- .3 United States of America, Federal Communications Commission (FCC)
  - .1 FCC (CFR47) EM and RF Interference Suppression.
- .4 IESNA LM-79-08, IES Electrical Method for the Electrical and Photometric Measurements of Solid State Lighting Products.

**1.2                    SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings in accordance with Electrical General Requirements Section for all light fixtures supplied under this contract.
- .2 Submit complete photometric data prepared by independent testing laboratory for luminaires where specified, for review by Consultant.
- .3 Photometric data to include: VCP Table spacing criterion.

**1.3                    SCOPE**

- .1 This contractor is responsible to supply and install all lighting fixtures as scheduled and/or indicated including lamp and those accessories required for a complete lighting system. This contractor must coordinate lighting installations with all other Divisions of this project.
- .2 All fixtures must be CSA approved or approved at this contractor's expense by the Special Inspection Division of the Electrical Safety Authority.

**1.4                    GUARANTEE**

- .1 Guarantees for materials replacement shall be as follows from date of ready for takeover.
  - .1 LED lamps: 3 months
  - .2 LED fixtures, and driver: 5 years.
- .2 The labour required to replace these ballasts, lamps or drivers must be included in the above guarantee, however only for the extent of the contract guarantee and warranty period as noted in Electrical General Requirements.

---

**Part 2                      Products**

**2.1                      FIXTURE CONSTRUCTION**

- .1        Fixtures must be constructed of 20 gauge (minimum) cold rolled steel. All metal edges require smooth finish.
- .2        Light leaks must be prevented by providing gasketting, stops, and barriers.
- .3        Fixtures must be finished in high reflective baked white enamel. This surface must have a reflectance of not less than 85%.

**FIXTURE LENS**

- .4        Unless otherwise noted fixture lenses shall be as follows:
  - .1            Lens thickness: 3.2 mm (1/8")
  - .2            Material: injection moulded clear prismatic virgin acrylic
  - .3            Frame: hinged, latched, steel.

**2.2                      LED FIXTURES**

- .1        Fixture LED's must be tested in conformance with IESNA LM80 standard.
- .2        LED's must be selected using a binning algorithm to ensure colour and lumen output of a given fixture are consistent, as well as meet or surpass ANSI C78.377 specification for the rated lifetime of the fixture. Colour accuracy between products must be within a 2-step MacAdam ellipse.
- .3        Luminaires must be tested to IESNA LM79 by an independent approved laboratory.
- .4        Luminaires must be tested prior to shipping.
- .5        Luminaires must be ULC certified and approved for use in Canada.
- .6        Fixtures must maintain a minimum of 90% of their initial light output for 60,000 hours. Submit test results upon request.
- .7        Lumen values indicated for fixtures in the project documents are to be considered as "absolute" or "delivered" values.
- .8        Other than for specialty fixtures, and unless otherwise indicated, the maximum driver current is to be 750 mA.

**2.3                      STANDARD EXIT LIGHTING UNITS**

- .1        Exit lighting units must conform to CSA C860, CSA 22.2 No. 141 (latest edition).
- .2        Housing: extruded aluminum housing, white finish.
- .3        Face and back plates: extruded aluminum.
- .4        Lamps: 2W LED.
- .5        Operation: 25 year.
- .6        Units are to be provided with three (3) pictogram legends indicating "left from here", "straight from here", and "right from here".

- .7 Face plate to remain captive for relamping.

## **2.4 SELF-POWERED COMBINATION EXIT/EMERGENCY LIGHTING UNITS**

- .1 Exit lighting units must conform to CSA C860, CSA 22.2 No. 141 (latest edition).
- .2 Housing: extruded aluminum housing. White Finish.
- .3 Face and back plates: extruded aluminum.
- .4 Lamps 2W LED (EXIT).
- .5 Operation: 25 year life.
- .6 Units are to be provided with three pictogram legends indicating “left from here”, “straight from here”, and “right from here”.
- .7 Face plate to remain captive for relamping.
- .8 Supply voltage: as noted on drawings.
- .9 Output voltage: 12 V DC.
- .10 Battery: sealed maintenance free 10 year life.  
Note: Battery must be capable of supplying the wattage indicated for a minimum of 30 minutes.
- .11 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.
- .12 Solid state transfer circuit.
- .13 Signal lights: “AC Power On” condition and “charging” condition.
- .14 Lamp heads: integral on unit, 345° horizontal and 180° vertical adjustment. Lamp type: minimum 4 watt LED.
- .15 Mounting: suitable for universal mounting directly on junction box and complete with knockouts for conduit. Removable or hinged front panel for easy access to batteries.
- .16 Cabinet: finish: white.
- .17 Auxiliary equipment:
  - .1 Test switch.

## **2.5 EMERGENCY LIGHTING UNITS**

- .1 Emergency lighting units must conform to CSA C22.2 No 141 (latest edition).
- .2 Supply voltage: as noted on drawings.
- .3 Output voltage: 12 V DC.
- .4 Battery: sealed, maintenance free, 10 year life.  
Note: Battery units must be capable of supplying the wattage indicated for a minimum of 30 minutes.

- .5 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.
- .6 Solid state transfer circuit.
- .7 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.
- .8 Signal lights: “AC Power ON” condition and “charging” condition.
- .9 Lamp heads: integral on unit, 345° horizontal and 180° vertical adjustment. Lamp type: minimum 4 watt LED.
- .10 Cabinet suitable for direct of shelf mounting to wall and complete with knockouts for conduit. Removable or hinged front panel for easy access to batteries.
- .11 Auxiliary equipment:
  - .1 Test switch.
  - .2 Ac input and DC output terminal blocks inside cabinet.
  - .3 Shelf.
  - .4 Cord and plug connection for AC. (**Not applicable on 347 V units**).

## **2.6 REMOTE EMERGENCY LIGHTING FIXTURES**

- .1 Remote emergency lighting fixtures must conform to CSA C22.2 No141 (latest edition).
- .2 Fixtures shall be small “micro” size or recessed style as indicated in the Light Fixture Schedule.
- .3 Fixtures must be adjustable type heads with canopy.
- .4 Fixtures are to be provided with protective lexan cube when specified in the Light Fixture Schedule.
- .5 Unless otherwise indicated surface mounted fixtures in washrooms, locker rooms, changerooms, and gymnasiums must be provided with wire guard.

## **2.7 ACCEPTABLE LIGHTING MANUFACTURERS**

- .1 Refer to the light fixture schedule as indicated on drawings.

## **2.8 ACCEPTABLE FIXTURE ENERGY LISTINGS**

- .1 Fixtures as noted on lighting fixture schedules are to be DLC or Energy Star listed as noted. Equal manufacturers shall supply proof of DLC/Energy Star listing as part of fixture approval and shop drawing process.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Locate and install luminaires as indicated. Luminaires are not to be supported from the roof deck. Provide additional Unistrut support channel and/or support from structure. Co-ordinate with consultant on site.



- .2 Ball align hangers must be provided for rod suspended fixtures.
- .3 Fixtures surface mounted to suspended ceilings must be secured through ceiling assembly to cross member supports. These supports are to be steel channels or angles independently secured **to structure** using # 12 “jack” chain. Each chain must be secured so no fixture weight is added to the ceiling assembly.
- .4 Plaster frames/flange kits must be provided by this Division for fixtures recessed in plaster and/or drywall ceilings.
- .5 Where specified, fixtures to be chain hung shall be hung using “jack” chain with a capacity to suit the fixture weight. Branch circuit wiring feeding these fixtures shall be AC90 cable “ty-wrapped” at 900 mm (36”) intervals along length of drop. Final appearance must be neat and professional.
- .6 Install exit lighting units with illuminated faces and chevrons/arrows indicating path(s) of exit as indicated. Unless otherwise noted install exit fixtures at 2400 mm (8'-0") above finished floor.
- .7 Install emergency lighting units and associated remote mounted fixtures as indicated.
- .8 Direct “heads” on units and remote mounted fixtures to illuminate path(s) of exit.
- .9 Install emergency lighting units and remote fixtures at 300 mm (12") below finished ceiling, unless indicated otherwise.
- .10 Provide a 15 A 120 V duplex receptacle (connected to circuit indicated) adjacent to unit. **This receptacle connection is to be no lower than 8'-0" (2400 mm) AFF.**
- .11 **Special installation: Secure fixtures to structure to conform to the Electrical Safety Code using “jack chain” NOT ceiling suspension wire. Where coreslab is used, suspension point must be independent of the one used for suspension of the ceiling assembly. As an alternate to jack chain the contractor may use a pre-manufactured aircraft cable suspension and fastening system as manufactured by Gripple (Gripple Cat. #HF02-10F2). Provide minimum 2 per fixture.**
- .12 All battery units are to be provided with a visible lamicaid label indicating the unit number as per drawings.

### 3.2 WIRING

- .1 Connect luminaires to lighting circuits as indicated.
- .2 Connect exit fixtures to exit lighting circuits and unit equipment (if applicable).
- .3 Connect unit equipment to circuits as indicated.
- .4 All wiring of remote emergency fixtures shall be minimum #10 T90 for each circuit and run in conduit. Wiring must be sized in conformance with manufacturer’s recommendations for distances required.

### 3.3 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.

---

**3.4 DELIVERIES**

- .1 Fixtures are to be completely assembled at the manufacturer's plant and delivered to the project site in original unitized containers. Ensure that a dry, protected and secure space is available for proper storage before scheduling delivery of fixtures.

**3.5 TESTING/CERTIFICATION**

- .1 At the completion of the project and in the presence of the consultant, test all exit and emergency fixtures. On company letterhead, the contractor is to prepare a chart indicating:
- .1 Project
  - .2 Date
  - .3 Equipment type
  - .4 Certification of correct connection
  - .5 Certification of correct operation
  - .6 Duration of test in minutes (minimum 30)
  - .7 Actual period of testing (time of day)

**3.6 ADDITIONAL INSTALLED EXIT SIGNS**

- .1 The electrical contractor is to include in their bid the cost to add five additional standard exit lighting units to be installed and tested in locations as directed by the consultant. Note: This installation and test will be occurring after the initial testing/certification testing is complete.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE).
- .2 Underwriter Laboratories of Canada (ULC).
- .3 International Electrotechnical Commission.
- .4 International Organization for Standardization (ISO).
- .5 National Electrical Manufacturers Association (NEMA).

**1.2 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings in accordance with Section 26 01 16.
- .2 Submit composite wiring diagrams and control schedule for each room control circuit type as proposed to be installed. Include load type, sequence of operation, sensor parameters, time delays, sensitivities and daylighting set points.
- .3 Catalog cut sheets with performance specifications demonstrating compliance with specified requirements.

**1.3 SCOPE**

- .1 This contractor is responsible to supply and install all equipment and control wiring as specified for the digital occupancy and daylight control systems. This contractor must coordinate these control systems with the lighting fixtures being supplied for the project to ensure intended function as specified.
- .2 Control Intent: Control Intent includes, but is not limited to:
  - .1 Defaults and initial calibration settings for such items as time delay, sensitivity, fade rates, etc.
  - .2 Initial sensor and switching zones.
- .3 All equipment must be CSA approved or approved at this contractor's expense by the Special Inspection Division of the Electrical Safety Authority.
- .4 Reference section 26 51 13 for Lighting information.
- .5 Reference section 26 05 75 for line voltage occupancy sensors and switches (hard wired analog).

**1.4 SYSTEM DESCRIPTION AND OPERATION**

- .1 The Digital Lighting Control (room level) as defined under this section covers the following equipment:
  - .1 Digital Room Controllers – Self-configuring, digitally addressable one, two or three relay controllers.

- .2 Digital Occupancy Sensors – Self-configuring, digitally addressable and calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
- .3 Digital Switches – Self-configuring, digitally addressable pushbutton switches, dimmers, and scene switches with two-way active infrared (IR) communications.
- .4 Digital Photosensors – Single-zone closed loop sensors with two-way active infrared (IR) communications can provide switching or dimming control for daylight harvesting.
- .5 Configuration Tools – Handheld remote for room configuration provides two-way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from an accessible location.

### **1.5 LIGHTING CONTROL APPLICATIONS**

- .1 Provide a minimum application of intended lighting control functions as detailed on design drawings and specified herein. Control functions shall include the following:
  - .1 Space Control Requirements – Provide occupancy/vacancy sensors with Manual-ON functionality in all spaces except toilet rooms, storerooms, or other applications where hands-free operation is desirable and Automatic-ON occupancy sensors are more appropriate. For spaces with multiple occupants, or where line-of-sight may be obscured, provide ceiling- or corner-mounted sensors.
  - .2 Bi-Level Lighting – Provide single zone, multi-level controls in any enclosed office, conference room, meeting room, and training room in all enclosed spaces except where variable dimming or multi-zone switching is used.
  - .3 Daylit Areas – All luminaires closest to the daylight source, and zoned separately from other fixtures in the space, shall be controlled separately from luminaires outside of daylit zones. Multiple-leveled switched daylight harvesting controls may be utilized for areas marked on drawings.

### **1.6 WARRANTY**

- .1 Provide a five-year complete manufacturer's warranty on all products to be free of manufacturers' defects.
- .2 The labour required to replace these products must be included in the above warranty, however only for the extent of the contract guarantee and warranty period as noted in Electrical General Requirements.

### **1.7 QUALITY ASSURANCE**

- .1 Manufacturer: Minimum 10-years experience in manufacture of lighting controls.

**Part 2 Products**

**2.1 MANUFACTURERS**

- .1 Basis of design product: WattStopper Digital Lighting Management (DLM). Acceptable alternates are subject to compliance and prior approval with specified requirements of this section, as one of the following:
  - .1 Cooper Controls (Wavelinx CAT)
  - .2 Acuity Controls (nlight).
- .2 Substitutions:
  - .1 All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by the design professional a minimum of 7 working days prior to the bid date and must be made available to all bidders.
  - .2 By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring.

**2.2 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR SYSTEM**

- .1 Wall or ceiling mounted (to suit installation) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor. Furnish the Company's system which accommodates the square-foot coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors and accessories which suit the lighting and electrical system parameters.
- .2 Digital Occupancy Sensors shall provide calibration and electronic documentation for the following features:
  - .1 Digital calibration and pushbutton programming for the following variables:
    - .1 Sensitivity – 0-100% in 10% increments
    - .2 Time delay – 1-30 minutes in 1 minute increments
    - .3 Test mode – Five second time delay
    - .4 Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
    - .5 Walk-through mode
    - .6 Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
  - .2 Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
  - .3 Device Status LEDs including:
    - .1 PIR Detection
    - .2 Ultrasonic detection
    - .3 Configuration mode
    - .4 Load binding
  - .4 Manual override of controlled loads.
  - .5 One or two RJ-45 port(s) for connection to DLM local network.

- .3 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.

WattStopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC

## **2.3 DIGITAL WALL SWITCHES**

- .1 Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5, and 8 button configuration; colour per architect, compatible with wall plates with decorator opening. 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 color buttons. Button replacement may be completed without removing the switch from the wall.
- .2 Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required to achieve multi-way switching.
- .3 The following switch attributes may be changed or selected using a wireless configuration tool:
  - .1 Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
  - .2 Individual button function may be configured to Toggle, On only or Off only.
  - .3 Individual scenes may be locked to prevent unauthorized change.
  - .4 Switch buttons may be bound to any load on a room controller and are not load type dependent; each button may be bound to multiple loads.
- .4 Two RJ-45 ports for connection to DLM local network.
- .5 Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required to achieve multi-way switching.
- .6 WattStopper product numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101.

## **2.4 DIGITAL POWER PACKS (ROOM CONTROLLERS)**

- .1 Room Controllers automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room Controllers shall be provided to match the room lighting load and control requirements. The controllers will be simple to install and will not have, dip switches, potentiometers or require special configuration. The control units will include the following features:
  - .1 Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
  - .2 Simple replacement – Using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf unit without requiring any configuration or setup.

- .3 Device Status LEDs to indicate:
  - .1 Data transmission
  - .2 Device has power
  - .3 Status for each load
  - .4 Configuration status
- .4 Quick installation features including:
  - .1 Standard junction box mounting
- .5 Plenum rated
- .6 Manual override and LED indication for each load
- .7 120 VAC, 60 Hz operation.
- .8 Zero cross circuitry for each load.
- .2 On/Off Room Controllers shall include:
  - .1 One or multiple relay configuration to suit control details
  - .2 Efficient 150 mA switching power supply
  - .3 Sufficient sensor connection points to suit indicated function without the requirement for additional hardware
  - .4 Discrete model listed for connection to receptacles, for schedule-based control of plug loads within the space.
    - .1 One relay configuration only.
    - .2 Automatic-ON/OFF configuration.
    - .3 Optional Network Bridge for BACnet MS/TP communications
  - .5 Three RJ-45 DLM local network ports.
  - .6 WattStopper product numbers: LMRC-101, LMRC-102, LMPL-101, LMPL-201.
- .3 On/Off Room/Dimming enhanced Room Controllers shall include:
  - .1 One or multiple relay configuration to suit control details.
  - .2 Efficient 250 mA switching power supply.
  - .3 One 0-10 volt analog output per relay for control of compatible ballasts and LED drivers.
  - .4 The following dimming attributes may be changed or selected using a wireless configuration tool:
    - .1 Establish preset level for each load from 0-100%.
    - .2 Set high and low trim for each load.
    - .3 Set lamp burn in time for each load up to 100 hours.
  - .5 Four RJ-45 DLM local network ports.
  - .6 Optional Network Bridge for BACnet MS/TP communications.
  - .7 WattStopper product numbers: LMRC-211, LMRC-212, LMRC-213, LMPL-201, LMRC-311, LMRC-312, LMRC-313.

## 2.5 DIGITAL PHOTO SENSORS

- .1 Digital photosensors work with room controllers to provide automatic switching or dimming daylight harvesting capabilities for any load type connected to a room controller. Closed loop photosensors measure the ambient light in the space and control a single lighting zone.
- .2 Digital photosensors include the following features:
  - .1 An internal photodiode that measures only within the visible spectrum and has a response curve that closely matches the photopic curve. The photodiode shall not measure energy in either the ultraviolet or infrared spectrums. The photocell shall have a sensitivity of less than 5% for any wavelengths less than 400 nanometers or greater than 700 nanometers.
  - .2 Sensor light level range shall be from 1-10,000 footcandles (fc).
  - .3 The capability of switching one-third, one-half or all lighting ON and OFF, or raising or lowering lighting levels, for each controlled zone, depending on the selection of room controller(s) and load binding to room controller(s).
  - .4 For switching daylight harvesting, the photosensor shall provide a deadband or a separation between the "ON Setpoint" and the "OFF Setpoint" that will prevent the lights from cycling after they turn off.
  - .5 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 user-selectable minimum level.
  - .6 Optional programmable wall switch override to allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise and lower lighting levels for a selected period of time or cycle of occupancy.
  - .7 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 that blinks to indicate data transmission
  - .9 Status LED indicates test mode, override mode and load binding.
  - .10 Recessed switch to turn controlled load(s) ON and OFF.
  - .11 One RJ-45 port for connection to DLM local network.
  - .12 An adjustable head and a mounting bracket to accommodate multiple mounting methods and building materials. The photosensor may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox.
- .3 Closed loop digital photosensors include the following additional features:
  - .1 An internal photodiode that measures light in a 100 degree angle, cutting off the unwanted light from bright sources outside of this cone.
  - .2 Automatic self-calibration, initiated from the photosensor, or a wireless configuration tool.
  - .3 Automatically establishes setpoints following self-calibration.



- .4 A sliding setpoint control algorithm for dimming daylight harvesting with a “Day Setpoint” and the “Night Setpoint” to prevent the lights from cycling.
- .5 WattStopper Product Number: LMLS-400.

## **2.6 DIGITAL ROOM CONTROL SYSTEMS**

- .1 Digital occupancy and daylight control system designed to control a small area of a building (room level). Digital devices connect to the room controller(s) using CAT 5e cables (LMRJ) with RJ-45 connectors which provide both data and power to room devices. Features of the system shall include:
  - .1 Plug n’ Go automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
  - .2 Simple replacement of any device in the system with a standard off the shelf unit without requiring commissioning, configuration or setup.
  - .3 Push n’ Learn configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices which are part of the local system.
  - .4 Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.

## **2.7 SYSTEM INPUT/OUTPUT**

- .1 Provide a means to allow seamless integration with third party devices to provide additional functionality to the Digital Lighting Management system via low voltage input/output interface. Wattstopper Product Number: LMIN-104.
- .2 Provide a means to integrate analog occupancy sensors to the Digital Lighting Management system via low voltage analog sensor input module. Wattstopper Product Number: LMIO-201.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install the work of this Section in accordance with manufacturer’s printed instructions unless otherwise indicated.
- .2 When using wire for connections other than the DLM local network (LMRJ Cat 5e with RJ-45 connectors), provide detailed point to point wiring diagrams for every termination. Provide wire specifications and wire colors to simplify contactor termination requirements.
- .3 Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings.
  - .1 Adjust time delay so that controlled area remains lighted for 5 minutes after occupant leaves area.

**.2 Program all room control systems to function in vacancy mode. User must manually turn lighting on with automatic delay to off.**

- .4 Install power packs in accessible maintenance areas unless noted otherwise. Provide access doors if power packs are installed above drywall ceilings.
- .5 It shall be the contractor's responsibility to locate and aim sensors in the correct location required for complete and proper coverage within the range of coverage as per the manufacturer's recommendations. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the respective rooms.
- .6 Provide written or computer-generated documentation on the commissioning of the system including room by room description including:
  - .1 Sensor parameters, time delays, sensitivities, and daylighting setpoints.
  - .2 Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
  - .3 Load Parameters (e.g. blink warning, etc.)
- .7 Re-commissioning – After 30 days from occupancy re-calibrate all sensor time delays and sensitivities to meet the Owner's Project Requirements. Provide a detailed report to the Architect / Owner of re-commissioning activity.

**3.2 FACTORY COMMISSIONING**

- .1 Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative who will verify a complete fully functional system.
- .2 The electrical contractor shall provide both the manufacturer and the electrical engineer with ten working days written notice of the system startup and adjustment date.
- .3 Upon completion of the system commissioning the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.
- .4 Factory commissioning shall include functional testing and documentation of the control system conforming to the "Functional Testing" requirements included in the current ASHRAE standard. This cost shall be included in the Tender Price.

**END OF SECTION**

**Part 1            General**

**1.1            STRUCTURED CABLING SYSTEM –TECHNICAL SPECIFICATIONS**

- .1            The following specification is written for a complete system and is to be used for pricing purposes in this addition. All systems must be connected to existing systems and compatibility must be verified prior to purchase of equipment.**
- .2            Each new school or Board building will require a structured cabling system to support the computer networks, telephone system, and other technologies that are to be used by the teachers, staff, and students. This system is to be installed by pre-qualified network cabling system installers (see section 1.5 a).
- .3            Hamilton Wentworth District School Board's Cable Infrastructure requires an end to end CommScope AMP Netconnect structured cabling system for copper (category 6) and fiber (OM3). All fiber and copper installs must be installed to the current standards and recommendations that are in this document. All HWDSB preapproved products are listed in 2.1a). Any Netconnect products outside this list must be preapproved in writing by HWDSB.
- .4            The cabling system must be installed by a ND&I with CommScope and backed by a CommScope AMP Netconnect 25 year System Warranty. The CommScope System Warranty shall be facilitated by the contractor and be established between HWDSB and CommScope. No third party certifications or third party warranties are allowed.
- .5            The successful contractor is required to furnish all labor, supervision, tooling, miscellaneous mounting hardware and consumables for each cabling system installed. The contractor must have ND&I status and be current and in good standing with CommScope for the duration of the project. The contractor shall staff each installation crew with the appropriate number of trained personnel in accordance with the ND&I program. After installation, the contractor must submit all documentation to support the warranty in accordance with CommScope's ND&I System Warranty Certification Program. The contractor must provide the completed warranty certificate to HWDSB within 90 days of 100% job completion.
- .6            Customer Contact Information  
  
Customer Name: Hamilton-Wentworth District School Board  
Customer Address: 20 Education Court, Hamilton, Ontario, L9A 0B9  
Customer Contact: Oscar Mbaya            Voice: 905 527-5092 X2130  
Email: ombaya@hwdsb.on.ca

**1.2            SUMMARY**

- .1            Section Includes: Equipment, materials, labor, and services to provide telephone and data distribution system including, but not limited to:
  - .1            Raceway, boxes, and cable tray
  - .2            Telephone and data cabling terminations

- .3 Optical fiber and terminations
- .4 Telecommunications outlets
- .5 Terminal blocks/cross-connect systems
- .6 Equipment racks and cabinets
- .7 System testing
- .8 Documentation and submissions

### 1.3 REFERENCES

- .1 Design, manufacture, test, and install telecommunications cabling networks per manufacturer's requirements and in accordance with local codes including the Electrical Safety Code (ESA), the Canadian Electrical Code (CEC – C22.1), the Ontario Electrical Code (OEC), requirements of all other authorities having jurisdiction, and particularly the following standards:
  - .1 ANSI/NECA/BICSI-568 - Standard for Installing Commercial Building Telecommunications Cabling
  - .2 ANSI/TIA/EIA Standards
  - .3 ANSI/TIA/EIA-568-C.0 -- Generic Telecommunications Cabling for Customer Premises, Amd. 2, 08-2012
  - .4 ANSI/TIA-568-C.1 -- Commercial Building Telecommunications Cabling Standard, Ed. C, Amd. S, 05-2012
  - .5 ANSI/TIA-568-C.2 – Balanced Twisted-Pair Telecommunication Cabling and Components Standard, Ed. C, 04-2014
  - .6 ANSI/TIA-568-C.3 - Optical Fiber Cabling Components Standard, Ed. C, Amd. 1, 10-2011
  - .7 ANSI/TIA-568-C.4 – Broadband Coaxial Cabling and Components Standard, Ed. C, 07-2011
  - .8 ANSI/TIA/EIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces
  - .9 ANSI/TIA/EIA-606(B) – The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
  - .10 ANSI/TIA/EIA-607(B) – Commercial Building Grounding and Bonding Requirements for Telecommunications
  - .11 ANSI/TIA/EIA-526-14B – Measurement of Optical Power Loss of Installed
  - .12 Multimode Fiber Cable Plant ANSI/TIA/EIA-758(B) – Customer-Owned Outside Plant Telecommunications Cabling Standard
  - .13 ANSI/TIA/EIA-862-A – Building Automation Systems Cabling Standard for Commercial Buildings
- .2 Install cabling in accordance with the most recent edition of BICSI publications:
  - .1 BICSI – Telecommunications Distribution Methods Manual
  - .2 BICSI – Cabling Installation Manual
  - .3 BICSI - LAN Design Manual
  - .4 BICSI – Customer-Owned Outside Plant Design Manual

- .3 Federal, Provincial, and local codes, rules, regulations, and ordinances governing the work, are as fully part of the specifications as if herein repeated or hereto attached. If the contractor should note items in the drawings or the specifications, construction of which would be code violations, promptly call them to the attention of HWDSB's representative in writing. Where the requirements of other sections of the specifications are more stringent than applicable codes, rules, regulations, and ordinances, the specifications shall apply.

#### **1.4 SYSTEM DESCRIPTION / SCOPE OF WORK**

- .1 Refer to supplied drawings for closet and node locations, distance of runs, number of wiring closets, etc.
- .2 Specify quantity of cabling runs to each wiring closet (copper and fiber). Supply and install Structured Cabling System as follows:
  - .1 Wiring closets totaling 3, following the designations of MC and TCs where MC is on the main level located nearest to WAN Fiber Demarc (Main Electrical Room).
  - .2 Fiber Interconnects between closets using the following specifications.
  - .3 MC to TC via First Floor Raceway (For TC on first floor)
  - .4 MC to TC via Riser (For TC on 2nd or 3rd floor)
  - .5 All patch panels, equipment, will be mounted on standard 19" floor standing relay racks as per specifications detailed in section 2.17 a).
  - .6 Vertical/horizontal fiber backbone cabling consists of 50/125 m multimode optical fiber cable installed from satellite closet to central closet. This backbone must be certified for 10 gigabit Ethernet performance. All strands of fiber are to be terminated using approved methods.
  - .7 Computer nodes located in office areas, teacher workrooms, regular class rooms, computer labs, library common areas, etc. will have various number of CAT6 drops terminated in an approved RJ45 jack outlet. Follow approved drawings for locations of drops.
  - .8 **Daycare area data drops for computer nodes and wireless access points shall be terminated in school wiring closet, on patch panel(s) separate from main school data drops.**
  - .9 **Daycare area voice drops shall consist of analog voice line cabling from main school demarcation point to each voice/data outlet as noted on plans.**

#### **1.5 SUBMITTALS**

- .1 General: Submit the following:
  - .1 Bill of materials, noting long lead time items
- .2 Shop drawings: Submit the following:
  - .1 System block diagram, indicating interconnection between system components and subsystems.
- .3 Product Data -- Provide catalog cut sheets and information for the following:
  - .1 Wire, cable, and optical fiber

- .2 Outlets, jacks, faceplates, and connectors
- .3 All metallic and nonmetallic raceways, including surface raceways, outlet boxes, and fittings
- .4 Terminal blocks and patch panels
- .5 Enclosures, racks, and equipment housings
- .6 Splice housings
- .7 Pathway devices
- .4 Project record drawings:
  - .1 Submit project record drawings at conclusion of the project and include:
  - .2 Approved shop drawings
  - .3 Plan drawings indicating locations and identification of work area outlets, nodes, wiring closets, and backbone (riser) cable runs
  - .4 Wiring closet termination detail sheets.
  - .5 Labeling and administration documentation.
  - .6 Warranty documents for equipment.
  - .7 Copper certification test result printouts and USB key or CD/DVD.
  - .8 Optical fiber power meter/light source test results.

#### **1.6 QUALITY ASSURANCE**

- .1 Refer to request for tender document – Instructions to Bidders for contractors approved for the work of this section. This selection is based upon favorable prior experience on the part of the customer.
- .2 The contractor shall conform to certification in the installation of CommScope (Netconnect AMP) systems where upon completion the contractor must provide official certification documentation.
- .3 Equipment and materials of the type for which there are independent standard testing requirements, listings, and labels, shall be listed and labeled by the independent testing laboratory.
- .4 Where equipment and materials have industry certification, labels, or standards, this equipment shall be labeled as certified or complying with standards.
- .5 Material and equipment shall be new, and conform to grade, quality, and standards specified. Equipment and materials of the same type shall be a product of the same manufacturer throughout.
- .6 Subcontractors shall assume all rights and obligations toward the contractor that the contractor assumes toward HWDSB and engineer/designer.

#### **1.7 WARRANTY**

- .1 Unless otherwise specified, unconditionally guarantee in writing the materials, equipment, and workmanship for a period of not less than fifteen (15) years from date of acceptance by HWDSB. HWDSB shall deem acceptance as beneficial use.

- .2 Transfer manufacturer's warranties to HWDSB in addition to the General System Guarantee. Submit these warranties on each item in list form with shop drawings. Detail specific parts within equipment that are subject to separate conditional warranty. Warranty proprietary equipment and systems involved in this contract during the guarantee period. Final payment shall not relieve you of these obligations.

## 1.8 SEQUENCE AND SCHEDULING

- .1 Submit schedule for installation of equipment and cabling. Indicate delivery, installation, and testing for conformance to specific job completion dates. As a minimum, dates are to be provided for bid award, installation start date, completion of testing and labeling.

## 1.9 USE OF THE SITE

- .1 Use of the site shall be at HWDSB's direction in matters in which HWDSB deems it necessary to place restriction.
- .2 Access to building wherein the work is performed shall be as directed by HWDSB.
- .3 Schedule necessary shutdowns of plant services with HWDSB, and obtain permission from HWDSB.
- .4 Proceed with the work without interfering with ordinary use of streets, aisles, passages, exits, and operations of HWDSB.

## Part 2 Products

### 2.1 MANUFACTURER

- .1 Hamilton Wentworth District School Board's Cable Infrastructure requires an end to end CommScope AMP Netconnect structured cabling system for copper (category 6) and fiber (OM3). No manufacturer alternatives are allowed.
- .2 Provide CommScope manufacturer products as named in individual articles in the below part list and at [www.commscope.com](http://www.commscope.com) if not listed.

Part Number	Description Code	Description
UN874043014/10	CS37P BLU C6 4/23U/UTP CPK 1KFT	CS37P ETL Verified Category 6 U/UTP Cable, plenum, blue jacket, 4 pair count, 1000 ft (305 m) length CommPak
UN874049714/10	CS37P WH T C6 4/23U/UTP CPK 1KFT	CS37P ETL Verified Category 6 U/UTP Cable, plenum, white jacket, 4 pair count, 1000 ft (305 m) length CommPak
760237627	USL600-BLK	Uniprise USL Series Modular Jack, RJ45, category 6, T568A/T568B, unshielded, without dust cover, black
760237629	USL600-A.WHT	Uniprise USL Series Modular Jack, RJ45, category 6, T568A/T568B, unshielded, without dust cover, alpine white

760237647	USL600-DC-GRY	Uniprise USL Series Modular Jack, RJ45, category 6, T568A/T568B, unshielded, without dust cover, gray
760257178	USL600-BL	Uniprise USL Series Modular Jack, RJ45, category 6, T568A/T568B, unshielded, without dust cover, blue
760257179	USL600-RD	Uniprise USL Series Modular Jack, RJ45, category 6, T568A/T568B, unshielded, without dust cover, red
760257181	USL600-GN	Uniprise USL Series Modular Jack, RJ45, category 6, T568A/T568B, unshielded, without dust cover, green
760257182	USL600-VI	Uniprise USL Series Modular Jack, RJ45, category 6, T568A/T568B, unshielded, without dust cover, violet
760237041	CPP-UDDM-SL-2U-481933307-1	Multimedia SL Series Patch Panel, front-load 6 module, straight, unloaded, 48-port
760237047	CPP- SDD M- SL-2U-48	Discrete Distribution Module Panel, SL, STP, 2U, 48 port
760237040	PP-UDDM-SL-1U-24	Multimedia SL Series Patch Panel, front-load 6 module, straight, unloaded, 24-port
760237046	CPP- SDD M- SL- 1U-24	Discrete Distribution Module Panel, SL, STP, 1U, 24 port
760249154		Faceplate Kit, 4 port, 110 connect, almond
760249145		Faceplate Kit, 1-gang, 2 port, white
700208143	R-006- DS-5L-FSU AQ	LazrSPEED® Riser Distribution Cable, 6 fiber single-unit
700208150	R-012- DS-5L- FSU AQ	LazrSPEED® Riser Distribution Cable, 12 fiber single-unit
760018556	R-024- DS-5L-FSU AQ	LazrSPEED® Riser Distribution Cable, 24 fiber single-unit
760018689	P-024- DS-5L- FSU AQ	LazrSPEED® Plenum Distribution Cable, 24 fiber single-unit
700009731	P-012-DS-5L-FSUAQ	LazrSPEED® Plenum Distribution Cable, 12 fiber single-unit
700009772	P-006-DS-5L-FSU AQ	LazrSPEED® Plenum Distribution Cable, 6 fiber single-unit
760036418	P-006-OD-5L-FSU BK	LazrSPEED® Indoor/Outdoor Plenum Distribution Cable, 6 fiber single-unit
760037374	P-012- OD-5L-FSU BK	LazrSPEED® Indoor/Outdoor Plenum Distribution Cable, 12 fiber single-unit



760230938	360DPis-12LC-LS	Adapter Panel, Black, 1000-Type, with 1 LazrSPEED® 12 fiber, MM LC ganged adapter, aqua, shuttered
760216754	360DPis-24LC-LS	Adapter Panel, Black, 1000-Type, with 12 LazrSPEED® MM duplex LC adapters, aqua, no shutter
760249998	EPX-1U-MOD-ENC	Standard Density 1U sliding shelf, accepts (3) LGX/1000 style splice cassettes, modules or panels, providing up to 36 duplex LC ports
760244927	G2-SP-24LCX-PT	LazrSPEED® Splicing cassette, 24LC , 900µm
760245399	G2-SP-12LCX-PT	LazrSPEED® Splicing cassette, 12LC , 900µm
760117887	MFC- LCF-09-5X	LazrSPEED® Fiber Qwik II-LC Connector™, field installable, aqua
760117911	MFC- LCF-09-5X-25	LazrSPEED® Fiber Qwik II-LC Connector™, field installable, aqua, 25 Pack
FEXLCLC21	FEXLC LC21-MX F003	LazrSPEED® 550 LC to LC, Fiber Patch Cord, 1.6 mm Simplex, Riser, aqua jacket, 3 ft
FEXLCLC21	FEXLC LC21- MX F007	LazrSPEED® 550 LC to LC, Fiber Patch Cord, 1.6 mm Simplex, Riser, aqua jacket, 7 ft
FEXLCLC21	FEXLC LC21-MXF010	LazrSPEED® 550 LC to LC, Fiber Patch Cord, 1.6 mm Simplex, Riser, aqua jacket, 10 ft
760235588	CCA- CAT6- PLENUM-WHITE-N018	CommScope® Category 6 U/UTP Cord, Plenum , RJ45 to Ceiling connector, 1.5 ft, white
760234921		Ceiling Connector Assembly (CCA) without cordage
UC1BBB2-0ZF003	UNC6-BL-3FT	Uniprise Category 6 U/UTP Patch Cord, RJ45 to RJ45, 4-pair, Non-Plenum, Blue Jacket

## 2.2 FABRICATION

- .1 Fabricate custom-made equipment with careful consideration given to aesthetic, technical, and functional aspects of equipment and its installation.

## 2.3 SUITABILITY

- .1 760237628 Provide products that are suitable for intended use, including, but not limited to environmental, regulatory, and electrical.

## 2.4 VOICE/DATA TELECOMMUNICATIONS SERVICE BACKBONE CABLE

- .1 Multimode 50/125 µm diameter tight-buffered OM3 optical fiber, 6 strand with 2 fibers for closet to closet and 4 spare fibers, with mechanical and transmission performance specifications that meet or exceed ANSI/TIA/EIA-568-C.0

**2.5 VOICE TELECOMMUNICATIONS STATION CABLE**

- .1 Solid copper, 24 AWG, FT6 Plenum, 100 balanced twisted-pair (UTP) Category 6 cables with four individually twisted-pairs. Manufacturer Part TE620P-BLRB.

**2.6 COMPUTER NODE CABLE (Copper)**

- .1 Solid copper, 24 AWG, FT6 Plenum, 100 balanced twisted-pair (UTP) Category 6 cables with four individually twisted-pairs. Manufacturer Part TE620P-BLRB.

**2.7 UNDERGROUND TELECOMMUNICATIONS CABLE (Optical Fiber)**

- .1 Multimode 50/125 µm diameter, armored, gel-filled optical fiber, with number of usable fibers, which meet or exceed the mechanical and transmission performance specifications listed in ANSI/TIA/EIA-568-C.0 and ASI/TIA/EIA-758(B).

**2.8 VOICE/DATA WORK AREA OUTLETS (Copper only)**

- .1 Single-gang mounting plate with four (4) openings containing the following devices:
  - .1 8-pin modular, Category 6, un-keyed, pinned to T568 (B) standards, white data jack for voice and red data jack for data.OR
- .2 Single gang mounting plate with two openings containing the following:
  - .1 8-pin modular, Category 6, un-keyed, pinned to T568 (B) standards, white data jack for voice and red data jack for data.

**2.9 DATA ONLY WORK AREA OUTLET**

- .1 Single-gang faceplate with 8-pin modular, category 6, un-keyed, red data jack, pinned to T568 (B) standards.

**2.10 VOICE ONLY WORK AREA OUTLET**

- .1 Single-gang faceplate with 8-pin modular, category 6, un-keyed, red data jack, pinned to T568 (B) standards.

**2.11 VOICE AND DATA PATCH CABLES**

- .1 Patch cords used at the telecommunication rack and at the workstation shall be AMP NETCONNECT Category 6, 24 AWG, 4-pair assemblies factory-assembled by CommScope. For every network drop installed two patch cables will be provide both red color; one for TC and one for the classroom workstation.

- .2 In the MC and TC, 2-foot patch cables shall be provided to connect between the data patch panels and network equipment (Quantity = Number of data drops). The second patch cable (10-foot) is for the PC end (Quantity = Number of data drops).

Notes:

Additional patch cables 1-2' blue patch cable plus 1-20' blue for each classroom for wireless APs.

Additional patch cables for TV outlets 1-2' violet cable plus 1-20' violet for each classroom.

## **2.12 PATCH PANELS**

- .1 19 in. rack mountable, 8-pin modular to insulation displacement connector (IDC) meeting Category 6 performance standards, and pinned to T568 (B) standards.
- .2 Red data jacks for data and blue data jacks for wireless access points, red data jacks for phone lines/fax, Black data jacks for facilities management equipment; BAS, S2 nodes and T-Link, digital signage.

## **2.13 RACK MOUNTED OPTICAL FIBER TERMINATION PANEL**

- .1 19 in. rack mounted optical fiber termination panel with cable strain relief, grounding lugs, slack storage and duplex LC connector panels with modules and splice trays.

## **2.14 SPLICE TRAYS**

- .1 Sized for 50/125 um multimode fibers, nonmetallic with clear plastic cover, 12-fiber splice capacity, and compatible with splice enclosure and splicing method.

## **2.15 OPTICAL FIBER CONNECTORS**

- .1 Ceramic tipped field installed LC connectors using epoxy adhesion, which meet or exceed the performance specifications in ANSI/TIA/EIA-568-C.0

## **2.16 OPTICAL FIBER PATCH CABLES**

- .1 Supply 50/125 µm duplex fiber patch cables 3m in length for each fiber backbone run.
- .2 Supply 2 spare patch cables as specified in 2.16 a.

## **2.17 EQUIPMENT RACKS**

- .1 The 19 in. equipment rack shall have the following minimum requirements:
- .1 Post Floor Mount 44 U, 10-32 single sided, 2 posts, Black frames – Electron Metal - Part # RK1FR2-194400 or equivalent.
- .2 Vertical cable management for patch panels and rack mount network components (1U size) – Electron metal - Part # CMRSTD054406 or equivalent.
- .3 The 19 in. rack should be located within each data closet with a minimum of 2 ft. clearance on all sides. Locate in the middle of each closet with front facing out to door. Top of rack should align in close proximity with cable tray extension and electrical outlets in each closet.

- .4 Communication rack layout shall be as follows (from top to bottom):
  - .1 Fiber tray
  - .2 Patch panels (1 1U horizontal management per 24 port patch panel)
  - .3 HWDSB network switches ( 5 1U horizontal management per closet)
  - .4 HWDSB UPS to be located at very bottom
  - .5 Rack shall have vertical management with door / cover on both sides

## **2.18 SPLICE HOUSING**

- .1 Encapsulated, re-enterable splice housing, sized as required with bonding straps, accessories, end caps and encapsulant as required.

## **2.19 SMARTBOARD AND PROJECTOR SCREEN DISPLAY TV CONNECTIONS**

- .1 The authorized AV contractor will be responsible to review the smartboard and projector screen display details and provide wiring, device outlets, and faceplates for all auxiliary outlets (i.e. HDMI, USB and audio). Refer to item 3.9 for authorized contractor listing.
- .2 The contractor is to use a Rapid Run wiring harness solution to accomplish this. This solution is to consist of runner cables, flying leads (connectors) and wall plates.
- .3 Refer to details on the drawings.

## **Part 3 Execution**

### **3.1 PRE-INSTALLATION SITE SURVEY**

- .1 Prior to start of systems installation, meet at the project site with HWDSB's representative and representatives of trades performing related work to coordinate efforts. Review areas of potential interference and resolve conflicts before proceeding with the work. Facilitation with the General Contractor will be necessary to plan the crucial scheduled completions of the equipment room and telecommunications closets.
- .2 Examine areas and conditions under which the system is to be installed. Do not proceed with the work until satisfactory conditions have been achieved.

### **3.2 HANDLING AND PROTECTION OF EQUIPMENT AND MATERIALS**

- .1 Be responsible for safekeeping of your own and your subcontractors' property, such as equipment and materials, on the job site. HWDSB assumes no responsibility for protection of above named property against fire, theft, and environmental conditions.

### **3.3 PROTECTION OF HWDSB'S FACILITIES**

- .1 Effectively protect HWDSB's facilities, equipment, and materials from dust, dirt, and damage during construction.
- .2 Remove protection at completion of the work.

### 3.4 INSTALLATION

- .1 Receive, check, unload, handle, store, and adequately protect equipment and materials to be installed as part of the contract. Store in areas as directed by the HWDSB's representative. Include delivery, unloading, setting in place, fastening to walls, floors, ceilings, or other structures where required, interconnecting wiring of system components, equipment alignment and adjustment, and other related work whether or not expressly defined herein.
- .2 Install materials and equipment in accordance with applicable standards, codes, requirements, and recommendations of federal, provincial, and local authorities having jurisdiction, and with manufacturer's printed instructions.
- .3 Adhere to manufacturer's published specifications for pulling tension, minimum bend radii, and sidewall pressure when installing cables
  - .1 Where manufacturer does not provide bending radii information, minimum- bending radius shall be 15 times cable diameter. Arrange and mount equipment and materials in a manner acceptable to the engineer and HWDSB.
- .4 Penetrations through floor and fire-rated walls shall utilize intermediate metallic conduit (IMC) or galvanized rigid conduit (GRC) sleeves and shall be firestopped after installation and testing, utilizing a firestopping assembly approved for that application.
- .5 Install station cabling to the nearest wiring closet, unless otherwise noted.
- .6 Installation shall conform to the following basic guidelines:
  - .1 Use of approved wire, cable, and wiring devices
  - .2 Neat and uncluttered wire termination
- .7 Attach cables to permanent structure with suitable attachments at intervals of 48 to 60 inches. Support cables installed above removable ceilings.
- .8 Install adequate support structures for 10 foot of service slack at each TR.
- .9 Support riser cables every three (3) floors and at top of run with cable grips.
  - .1 Limit number of four-pair data riser cables per grip to fifty (50)
- .10 Install cables in one continuous piece. Splices shall not be allowed except as indicated on the drawings or noted below:
- .11 Copper termination and management hardware shall be installed in the following manner:
  - .1 Cables shall be dressed and terminated in accordance with the recommendations made in the TIA/EIA-568-C document and/or CommScope recommendations.
  - .2 Pair untwist at the termination shall not exceed one-half an inch for Category 6 connecting hardware.
  - .3 Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.

- .4 Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- .5 The cable jacket shall be maintained as close as possible to the termination point.
- .6 Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.
- .12 Fiber optic termination hardware shall be installed in the following manner:
  - .1 Fiber slack shall be neatly coiled within the fiber termination panel. No slack loops shall be allowed external to the fiber panel(s).
  - .2 Each cable shall be individually attached to the respective termination panel by mechanical means. The cables strength member(s) shall be securely attached the cable strain relief bracket in the panel.
  - .3 Each fiber cable shall be stripped upon entering the termination panel and the individual fibers routed in the termination panel.
  - .4 Each cable shall be clearly labeled at the entrance to the termination panel. Cables labeled within the bundle shall not be acceptable.
  - .5 Dust caps shall be installed on the connectors and couplings at all times unless physically connected
- .13 Wireless access points and smartboard projectors are to be installed by this contractor as part of base contract. The supply of these devices will be part of cash allowance.

### **3.5 GROUNDING**

- .1 Bond and ground equipment racks, housings, and raceways.
- .2 Connect cabinets, racks, and frames to single-point ground which is connected to building ground system via #6 AWG green insulated copper grounding conductor.

### **3.6 LABELING**

- .1 Vendor to provide the following:
  - .1 Label each cable with permanent self-adhesive in the following locations:
    - .1 On front receptacle box for each jack at computer node end
    - .2 On front panel of the wiring closet patch panel or punch block.
    - .3 Naming convention used shall be as follows for computer node end:
      - .1 closet # -patch panel#-port#
    - .4 Naming convention used shall be as follows for wiring closet end:
      - .1 Each rack labeled with a number starting at 1 per closet
      - .2 Each patch panel labeled with a number starting at 1 per closet
      - .3 Each port on patch panel labeled with a number starting at 1 per closet
  - .2 Labels shall be machine-printed. Hand-lettered labels shall not be acceptable.

### **3.7 TESTING**

- .1 Testing shall conform to ANSI/TIA/EIA-568-C.0 standard. Testing shall be accomplished using level IIe or higher field testers.
- .2 Test each pair and shield of each cable for opens, shorts, grounds, and pair reversal. Correct grounded, and reversed pairs. Examine open and shorted pairs to determine if problem is caused by improper termination. If termination is proper, tag bad pairs at both ends and note on termination sheets.
  - .1 Perform testing of copper cables with tester meeting ANSI/TIA/EIA-568-C.0 requirements.
  - .2 If horizontal cable contains bad conductors or shield, remove and replace cable.
- .3 Initially test optical cable with a light source and power meter utilizing procedures as stated in ANSI/TIA/EIA-526-14B: OFSTP-14B Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant and ANSI/TIA/EIA-526-14B Measurement of Optical Power Loss of Installed Singlemode Fiber Cable Plant. Measured results shall be plus/minus 1 dB of submitted loss budget calculations. If loss figures are outside this range, test cable with optical time domain reflectometer to determine cause of variation. Correct improper splices and replace damaged cables at no charge to HWDSB.
  - .1 Cables shall be tested at 850 and 1300 nm for multimode optical fiber cables
  - .2 Bi-directional testing of optical fibers is required.
- .4 Perform optical time domain reflectometer (OTDR) testing on each fiber optic conductor. Measured results shall be plus/minus 1 dB of submitted loss budget calculations.
  - .1 Submit printout for each cable tested.
  - .2 Submit CD/DVD with test results and program to view results.
- .5 Where any portion of system does not meet the specifications, correct deviation and repeat applicable testing at no additional cost to HWDSB.

### **3.8 FIELD QUALITY CONTROL**

- .1 Employ job superintendent or project manager during the course of the installation to provide coordination of work of this specification and of other trades, and provide technical information when requested by other trades. This person shall be responsible for quality control during installation, equipment set-up, and testing.
- .2 Installation personnel shall meet manufacturer's training and education requirements for implementation of extended warranty program.

### **3.9 HWDSB Authorized AV Contractors 2018**

- .1 Refer to request for tender document – Instructions to Bidders for contractors approved for the AV work of this section. This selection is based on a prequalification process.

**END OF SECTION**

**Part 1 General**

**1.1 CO-ORDINATION**

- .1 The following specification is written for a complete system and is to be used for pricing purposes in this addition. All systems must be connected to existing systems and compatibility must be verified prior to purchase of equipment.**
- .2 The cost for this sub-trade to supply and install this system will be carried by the electrical sub-contractor. The electrical contractor is to provide all raceways as noted on the drawings and within these documents.
- .3 The following specifications are provided as a guideline for the electrical contractor to understand the work of this sub-trade.
- .4 The electrical contractor is to include in the tender all costs required to co-ordinate work with this sub-trade.

**1.2 SHOP DRAWINGS**

- .1 Submit shop drawings and product data in accordance with Section 26 01 16.
- .2 This data is to include a full system riser diagram indicating every proposed device including wiring requirements.

**1.3 OPERATION AND MAINTENANCE DATA**

- .1 Submit data for inclusion in maintenance manuals specified in Section 26 01 16.
- .2 Data must include parts list, maintenance and manufacturer contact numbers.

**1.4 SYSTEM REQUIREMENTS**

- .1 The core school system shall be a complete fully integrated communication system capable of providing a complete operational Public Address and Intercom systems. Public address system MUST be integrated/connected to the School Board provided IP telephone system as part of this project. Products listed in this specification shall form the basis of design.
- .2 This system must include:
  - .1 Voice paging to selected areas from administrative consoles or room telephones.
  - .2 Broadcast of pre-recorded music and programs from local AM/FM tuner/ CD player/pre-amp.
  - .3 Other capabilities as listed following.
- .3 The Daycare Area shall have the core school Public Address and Intercom system extended but separately zoned such that general paging will not sound in Daycare Areas. Emergency or Lockdown paging shall sound throughout Daycare Areas.**



- .4 The systems must be complete with a software program for setting up and editing time and school program scheduling. This program must be loaded on at least one secretarial workstation. Use of the program must be included in the training session. Systems not having this program will NOT be considered.

## **1.5 QUALITY ASSURANCE**

- .1 Customer contact information:  
Customer Name: Hamilton Wentworth District School Board  
Customer Address: 20 Education Court, Hamilton, Ontario, L9A 0B9  
Confirm approved public address sub-contractors with customer contact.

## **Part 2 Products**

### **2.1 SYSTEM CRITERIA**

- .1 The public address system shall consist of the Central Control Unit, Administrative Control Consoles, Speakers, Internal Master Clock, and all other necessary auxiliary devices to provide the operation specified herein. Provide auxiliary power supplies for digital clocks throughout the floor spaces to suit the quantity of clocks per plans.
- .2 The system specified is based on equipment manufactured by CareHawk and is meant to establish a standard of quality. It is not intended to discourage other equipment manufacturers (who meet the specification) from bidding. However, only manufacturer authorized and certified dealers are to install, connect and program the specified equipment.
- .3 Life safety features shall include but not be limited to; priority based access to voice functions, emergency paging, emergency call-in, covert PC based call-in, pre-recorded emergency announcements, external and internal telephone access, integrated video surveillance, and optional district wide communication functions. Paging systems, traditional school intercom systems, or any system that does not include the above minimum features shall not be considered.
- .4 The system shall be of a core design vintage dating from the year 2000 or later. systems that use designs dating from before the year 2000 shall not be considered.
- .5 The system shall be an event driven design. Systems using a polling method design shall not be considered.
- .6 The manufacturer shall provide a **five year** warranty against defects in material and workmanship. All materials shall be provided at no expense to the owner during normal working hours. The warranty period shall begin on the date of acceptance by the owner/consultant. Any warranty less than five years shall not be considered.
- .7 Software service packs released from time to time shall be available to the user for the life of the product at no additional cost.

- .8 The public address sub-contractor supplying the equipment shall show satisfactory evidence, upon request, that they maintain a fully equipped service organization capable of furnishing adequate inspection and service to the system, including replacement parts. The vendor shall be prepared to offer a service contract for the maintenance of the system after the guarantee period. The bidder shall produce evidence that they have a fully experienced and established service organization for at least five years and proven satisfactory installations during that time.

## **2.2 CENTRAL MICROPROCESSOR CONTROL PAGING/INTERCOM SYSTEM**

- .1 This system shall be a CareHawk Cat. # CH1000 Series and shall provide the following features and functions:
- .1 The system shall contain natively RS232, RS485, USB, and Ethernet ports for communication to any third party system. Systems that do not contain all of the above communication ports or require additional equipment shall not be considered.
  - .2 The system shall contain five open collectors, three dry contacts, and six general purpose inputs for third party system integration or for general panic buttons. It shall be possible to expand inputs or outputs to any number needed. Systems not supporting the minimum inputs and outputs or able to expand to any number shall not be considered.
  - .3 The system central cabinet shall be a wall mounted rack style. Total weight of the central cabinet shall not exceed 35 lbs. Install in a rack similar to Mid-Atlantic DWR series.
  - .4 The system shall have integrated surge protection for all audio ports and switching/line card ports. Said surge protection shall be replaceable in the field with no need to return parts for repair.
  - .5 The system shall use Class D digital amplifier with at least 250 Watts RMS and 300 Watts peak output. Amplifier distortion shall not exceed 0.2% at 90% load. The Class D amplifier shall be direct drive 25V constant voltage type. Systems using Class B amplifiers or amplifiers not capable of 0.2% maximum distortion shall not be considered.
  - .6 The system shall filter all voice signals through a Digital Signal Processor (DSP) to maximize voice intelligibility.
  - .7 The system shall have 45 Ohm conversion modules available on a switching/line cards basis to convert the 25V audio signal to 45 Ohm for use with 45 Ohm speakers.
  - .8 The system amplifiers shall have a built in pink noise generator for testing speaker quality and audio levels.
  - .9 The system shall have at least 25 tones available for bells, reminders, and other events.
  - .10 The system shall support WAV type audio files. The user shall be able to add 25+ custom WAV files for use as pre-recorded announcements, bells, reminders, pre-announce tones, or any other system tone. Systems not allowing users to add WAV files or do not allow for the use of WAV files for any system tone shall not be considered.

- .11 The system shall support remote switching/line cards with 16 and 32 audio ports sizes available. A single central cabinet shall support up to eight 32 port cards. The switching/line card shall be powered from the central cabinet out to 2700 feet away from the central cabinet.
- .12 The system shall support up to eight FXS Caller-ID enabled telephone ports. FXS ports shall be added as needed in single port configurations. FXS ports shall be used to interface with system Administrative phones, standard telephones, and PBX/KSU/iPBX/VoIP telephone systems. Systems that use proprietary telephone ports for Administrative phones or cannot provided eight FXS ports for PBX/KSU/iPBX/VoIP telephone system integration shall not be considered.
- .13 The system shall contain an integral master clock. Systems that do not have an integral master clock shall not be considered.
- .14 The system master clock shall be capable of being synchronized by a Network Time Sever (NTP).
- .15 The system master clock shall provide for automatic daylight saving time adjustment with leap year programming. Systems that require user intervention for daylight savings events shall not be considered.
- .16 The system master clock shall support unlimited schedules with unlimited events on said schedules.
- .17 The system master clock shall be calendar based capable of future event programming at least 30 years in the future.
- .18 The system master clock shall allow for scheduling tone events, output events, program source events, and video camera events. Systems not capable of scheduling all of the above event types shall not be considered.
- .19 The system shall not require an Administrative console to operate. All system functions shall be accessible via telephone codes from any internal or external telephone.
- .20 The system shall allow for the use of normally open, normally closed, wireless, and virtual call buttons.
- .21 The system shall allow for user-programmable room number assignment in the form of 3, 4, 5 or 6-digit alphanumeric format for architectural room numbering and a 60 character alpha-numeric caller ID description associated with each audio port.
- .22 The system shall allow for a minimum of 64 page/time/program zones that can be assigned and configured as desired.
- .23 The system shall allow for the assigning of each call-in button to one or more of 32 distinct call-in destination groups.
- .24 The system administrative telephone shall allow for the user to view the alphanumeric room address and the caller-ID information of the calling station and the call priority (e.g., emergency, normal) on the display. The administrative telephone shall use distinctive ringing patterns to annunciate the type of call.

- .25 The system shall communicate with each classroom loudspeaker hands-free. The staff member or occupant in the classroom need not operate any buttons to reply to a call. The Administrative telephone operator shall be able to use the hands-free speaker phone or handset on an Administrative telephone. Systems requiring “push to talk” shall not be considered.
- .26 The system shall operate under the following audio priority scheme. Systems not following the audio priority scheme listed below shall not be considered.
  - .1 An emergency page suspends all other audio
  - .2 An emergency tone suspends all other audio except the above
  - .3 A normal page suspends all other audio except the above
  - .4 A tone suspends all other audio except the above
  - .5 A program source audio event suspends nothing
  - .6 Interrupted lower priority functions shall be restored after conclusion of the higher priority function.
- .27 The system shall allow a call-in to be escalated from a normal call-in to an emergency call-in at any time by pressing the call button twice within 2 seconds.
- .28 The system shall allow for any connected telephone to place an emergency voice paging announcement.
- .29 The system shall use a PC based GUI scheduling tool for schedules and tone management. This tool shall not allow access to any system configuration controls. This tool shall not prevent the system from operating when being used. This tool shall allow the user to schedule events and manage tones over the local LAN/WAN and the Internet. It shall not be required to be directly connected to the central system to use this tool.
- .30 The system shall have a built in 30 day log of every system function and access.
- .31 The system shall have a built in real time system diagnostics application.
- .32 The system shall allow for system diagnostics, system log access firmware updates, and programming over the local LAN/WAN or over the Internet.
- .33 **The system must be compatible with latest windows operating systems.**
- .34 **System shall interface to School Board provided VOIP phone system. Provide connection to analog port at VOIP system. Coordinate with School Board VOIP supplier.**
- .35 Equal systems by Telecor and Bogen Multicom will be accepted.

## 2.3 CONTROL SYSTEM

- .1 The system shall contain a central microcontroller capable of a minimum of 500 MHz processing speed to allow for the addition of future features. LIFE SAFETY SYSTEMS with microcontrollers that run less than 500 MHz shall not be considered.
- .2 The system shall have flash based removable storage media of a size no smaller than 1 gigabyte. It shall be possible to remove the storage media from one system to another like system with no need to adjust the configuration files. LIFE SAFETY SYSTEMS that do not use removable flash based media or do not have at least 1 gigabyte of storage shall not be considered.

- .3 The system shall have at least 512 Megabytes of system ram. Said RAM shall be removable and upgradable. LIFE SAFETY SYSTEMS that do not use removable RAM or cannot be upgraded not be considered.

## **2.4 ADMINISTRATIVE CONTROL CONSOLE**

- .1 The system optional Administrative telephone Cat. #AP1 shall have the following features:
  - .1 Desk & wall mountable.
  - .2 Minimum 8 line by 20 character back lit display.
  - .3 Wizard driven menu system for ease of use.
  - .4 200 speed dials.
  - .5 Head set compatible.
  - .6 Integrated speaker phone for hands free use.
- .2 Provide two (2) ACC5 handsets as noted (main school office, and guidance office).

## **2.5 MIXER/AM/FM TUNER/CD PLAYER**

- .1 TOA Cat. #DT 930 AM/FM Tuner Denon Cat. #DN-500C/CD Player complete with pre-amp section providing the following:
  - .1 one priority microphone input
  - .2 three low-impedance microphone inputs
  - .3 three selectable auxiliary high impedance inputs
  - .4 two bridging inputs
  - .5 master gain control
  - .6 output level graph
  - .7 monitor speaker
  - .8 Cabinet dimensions are 13-1/2" wide X 7-1/2" deep X 3-1/4" high.
- .2 AM/FM Tuner
  - .1 AM: Frequency range - 535 to 1605 KHz
  - .2 Usable sensitivity - 20 UV at S/N 20 dB
  - .3 FM: Frequency Range - 88 to 108 KHz
  - .4 Usable sensitivity - 3 UV at S/N 30 dB
  - .5 Frequency response: - dB 50-10,000
  - .6 Distortion: - Less than 1.5%
  - .7 Antenna: - Standard RG-59U connector
  - .8 Controls: - AM/FM switch, tuning control, off/on & tone control
- .3 CD Player
  - .1 Digital optical output.
  - .2 MASH 1-bit DACsystem and advanced digital servosystem.

- .3 ID scan.
  - .4 Easy to read disc location display.
  - .5 Program memory.
  - .6 Quiet loading mechanism.
  - .7 Infra-red remote control unit supplied with 10-key direct access and power on/standby button.
  - .8 Frequency response 2Hz-20Hz (+/-1dB).
  - .9 Dynamic range 92db.
  - .10 S/N 100 db.
  - .11 Rack mounting capability.
  - .12 MP3 playback
- .4 These units along with a RDL Cat. # RU-MX4 (mixer), Cat. # RU-SP1 (monitor speaker), Cat. # RU-PA5218 (audio power amplifier) c/w rack adapters are to be installed in a counter mounted equipment rack located in the reception area of the main office. This rack should be equal to MID Atlantic RK/BRK Series complete with backplate and unit sized to suit components.

## **2.6 DESKTOP MICROPHONE**

- .1 The desktop microphone shall be complete with the following features;
  - .1 Tailored frequency response for intelligible voice reproduction.
  - .2 Omnidirectional dynamic.
  - .3 Frequency response of 150 to 6000 Hz.
  - .4 Locking push-to-talk switch.
  - .5 Combination of black and stainless steel finish.
- .2 Acceptable manufacturer shall be:  
TOA Cat. #PM-660U

## **2.7 CALL-IN SWITCHES**

- .1 The call-in switch shall enable staff to initiate a call to a designated DA-1, Administrative Control Console or console display unit. It shall be used with an associated speaker assembly.
- .2 The call-in switches shall be a momentary contact spring return type. Mounted on a stainless steel plate suitable for flush surface mounting on a single gang back box. Colour by architect.
- .3 The call-in switches shall be Dukane Cat. #PCS499 or equal as required.

## **2.8 NON-DIAL TELEPHONE HANDSETS**

- .1 Provide non dial telephone handsets in locations as indicated on the drawings (Mechanical Rooms etc.). The handsets shall operate in conjunction with the local room speaker or paging horn. Removing the handset from it's cradle shall "take-over" intercom communications being transmitted to the speaker and provide full duplex communications between the two parties.

- .2 The handset shall have a standard carbon granular transmitter, and associated dynamic receiver with built in varistor anti-click circuit.
- .3 The telephone shall also include an anti-side tone balancing network of the transformer type to improve clarity and intelligibility and to provide balanced line transmission. Telephones without the balancing network of the transformer type will not be accepted.
- .4 The handset faceplate must be complete with a call in switch matching the previously noted specification.
- .5 The telephone handsets shall be a CareHawk Cat. #HS140 c/w call switch and shall be supplied and installed as indicated on the plans. The handsets installed in the General Purpose Room and Cafeteria must be mounted in a recessed enclosure equal to Hoffman Cat. #A-FDF1212P complete with the following features:
  - .1 Continuous hinge.
  - .2 14 gauge galvanized steel door frame with ANSI 61 grey polyester powder finish.
  - .3 Rugged black composite slide latch.

## 2.9 SPEAKERS

- .1 Flush mounted wall speaker in noted room consoles shall consist of a McBride model # 8LS821-19 speaker complete with a matching transformer McBride model # MCT7025. **Wall speakers within child care area are to be complete with volume knobs.**
- .2 Flush ceiling speakers shall be a McBride model # 8LS821-19 speaker complete with a matching transformer McBride model # MCT7025, flush round back box McBride model # MC10E, one pair of support rails McBride model # MC100, and a round speaker baffle McBride model # MC11W.
- .3 Surface paging speakers (other than those in the gym) shall be a McBride model # 8LS821-19 speaker complete with a matching transformer McBride model # MCT7025, surface square back box McBride model # SMC20E, and a square speaker baffle McBride model# MC25W.
- .4 The gym paging speakers shall be a Fourjay model # 416-TF speaker complete with integral driver, recessed square back box, and a square (16 ga stainless steel) speaker baffle.
- .5 Exterior canopy paging speakers shall be weatherproof rated suitable for recess mounting in metal soffit with variable tap line matching transformer and sealed driver unit.
- .6 All interior speaker baffles are to be **bright white**. At the exterior canopies the speaker finish shall be custom to match soffit.

## 2.10 INTERIOR HORN SPEAKERS

- .1 Interior horn speakers where noted shall be complete with the following features:
  - .1 15 watt continuous power capacity.

- .2 375-14, 000 Hz. Frequency response.
- .3 Universal bracket for complete horizontal and vertical adjustment.
- .4 Grey baked epoxy finish.
- .2 Acceptable manufacturer shall be TOA Cat. #SC-615T.

#### **2.11 EXTERIOR HORN SPEAKERS**

- .1 Speakers shall be weatherproof rated suitable for surface wall mounting and be compact horn style with variable tap line matching transformer and sealed driver unit. Finish shall be textured white.
- .2 This contractor is to ensure that each speaker is wired as a home run to core school public address control panel.
- .3 **The electrical contractor is responsible to have these speakers painted with a baked on enamel at the manufacturer's factory or at a facility of his choice. Colour and colour chip will be provided by the Architect.**
- .4 Acceptable product:
  - .1 Fourjay Cat. #416-TF

#### **2.12 EMERGENCY CALL STATION**

- .1 Provide where noted on the drawings, an emergency call station consisting of a Nortel style door frame with stainless steel faceplate. Station may only be reset by attending the "call site".

#### **2.13 CABLE**

- .1 The system shall be capable of using CAT 5e unshielded cabling. Systems not capable of using all of the above wire types shall not be considered.
- .2 The system shall be capable of using two wire conductors for a speaker and call button referred from herein as a 2-wire circuit. It shall be possible to mix 2-wire and standard 4-wire circuits on the same switching/line card. Systems that require more than two conductors or require shielded cable shall not be considered.
- .3 All required cable is to be supplied and installed by public address sub-contractor and in a conduit network supplied and installed by the electrical contractor.
- .4 Cable shall be as indicated on the public address sub-contractors riser diagram submitted as a shop drawing.

#### **2.14 UNIVERSAL WASHROOM**

- .1 This sub-contractor is to provide a connection from the emergency call button in the universal washroom to the public address system to signal a priority call. Emergency call button shall also interface to universal washroom door operator controller to release door upon press of call button.



## **2.15 DIGITAL CLOCKS**

- .1 Provide rectangular digital clocks in all locations (outside of classrooms) as shown on design drawings as part of the central clock system.
- .2 Administration, staff, corridor, and similar room clocks shall be equal to Carehawk Cat. #24ZB20 (2" digital clock).
- .3 Gym clocks shall be equal to Carehawk Cat. #24ZB40 (4" digital clock). Provide wire guards for gym clocks.
- .4 Classroom clocks shall be equal to Carehawk Cat. #24ZBP12R (12" analog battery clock).

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Confirm all necessary wiring requirements with manufacturer/sub-contractor prior to tender close.
- .2 All wiring for this section must be installed in conduit.
- .3 Install wiring and components in accordance with manufacturers' recommendations.
- .4 Interface gym and general purpose room amplifiers with respective hearing assist systems specified.

### **3.2 TESTING**

- .1 The public address sub-contractor must provide inspection, initial test, required adjustments, commissioning verification and certification of the system. Confirm room numbers with Board representative.
- .2 All lines shall be tested for continuity, ground and shorts. An impedance test shall be done on each and every speaker and a report shall be submitted to the Engineer.
- .3 The Supplier shall test the system to ensure proper operation and make any changes or corrections to the system if any defects occur at no cost to the owner.
- .4 The Contractor shall include in his Tender price, all costs required for the Suppliers Technician's visit and testing.
- .5 All junctions shall be documented and shown on as built drawings showing locations.
- .6 Furnish upon completion of work, a letter as evidence that such tests and instructions have been performed to owners satisfaction, and to indicate that:
  - .1 System complies with system supplier's recommendations.
  - .2 The warranty on all new equipment installed on the public address system is for a one year period from the date of project substantial completion.
  - .3 The warranty will include replacement on materials including all labour charges.

**3.3 PROGRAMMING**

- .1 Programming of “paging access” and “call status” to the various areas of the facility must be co-ordinated between the users at the commissioning stage of the project. This sub-contractor is to account for this in the tender.

**3.4 INSTRUCTION TO OPERATORS**

- .1 Perform a final test of all circuits in the presence of the owner’s representative, and instruct his operating personnel on operation of various equipment. All final tests must be performed at the convenience of these individuals. (Allow a minimum of four hours).
- .2 Supply three (3) booklets and complete schematic of the system for future maintenance of the equipment.
- .3 Provide three (3) copies of complete operating manuals of each system installed.

**3.5 SERVICE AND MAINTENANCE**

- .1 The contractor shall, at the owner’s request, make available a service contract offering continuing factory authorized service of this system after the initial warranty period.
- .2 The system manufacturer shall maintain engineering and service departments capable of rendering advice regarding installation and final adjustment of the system.

**3.6 IN-SERVICE TRAINING**

- .1 The public address sub-contractor shall provide a minimum of four hours of in-service training for this system, which is to consist of all system functions and scheduling software.
- .2 Operators Manuals and Users Guides shall be used at the time of this training.
- .3 This training is for all system users to become familiar with all operating aspects of the system. Schedule session with owner to ensure all required individuals are present.
- .4 The user shall have access to telephone support from the manufacturer at no additional cost for the life of the product.
- .5 Once the training session is complete to the satisfaction of the owner obtain a “confirmation of training session” and include in the appropriate section of the maintenance manual.

**END OF SECTION**

**Part 1            General**

**1.1            SHOP DRAWINGS**

- .1      Submit shop drawings for each system in conformance with the Electrical General Requirements Section.

**1.2            PRODUCT/MAINTENANCE DATA**

- .1      Submit product/maintenance data for inclusion in maintenance manual conforming to the Electrical General Requirements Section.

**1.3            SCOPE**

- .1      **The following specification is written for a complete system and is to be used for pricing purposes in this addition. All systems must be connected to existing systems and compatibility must be verified prior to purchase of equipment.**
- .2      The contractor shall install and provide all labour, material, equipment, necessary to implement a proprietary intrusion alarm system as described in the following specification. The contractor is permitted to engage sub-contracts on all of the requirements of the alarm system. The contractor is responsible for the cost of all damages, which are the result of System installation.
- .3      All cable and wiring must conform to Electrical Safety Code and applicable Building codes.
- .4      All wiring shall be installed in conduit provided.
- .5      No exposed wiring is permitted, wiring must be fished where technically possible, and if not concealed it must be installed in raceway.
- .6      The contractor is to be in attendance during inspection and testing of the system installation.

**Part 2            ACCESS CONTROL AND ALARM MONITORING (ACAM) SYSTEM**

**2.1            Overview and System Architecture**

- .1      The Access Control and Alarm Monitoring (ACAM) system consists of credential readers, servers, software, control panels, workstations, enrollment peripherals, door sensors and locking devices. Credential readers typically consist of card/fob readers. Door sensors typically consist of door position contacts and request-to-exit devices. Locking devices typically consist of electric strikes, electric locks or electromagnetic locks. All credential readers, door sensors and locking devices are wired to Security Data Gathering Panels (DGPs), which monitor and manage door devices and sensors, grant/restrict access as well as communicate alarms.

- .2 The ACAM system architecture shall be IP-based. Door sensors and locking devices shall be connected via low voltage cabling to DGPs located in secure locations. DGPs shall be connected to the centralized ACAM server in HWDSB head offices, via a pre-establish VLAN/WAN of the base- building converged network, utilizing a Fast Ethernet 10/100 or 1 GB, TCP/IP network, which manage and store all access control information relating to users and administrators. Workstations connected, via VLAN/WAN, to the ACAM server shall allow administrators to monitor and manage the system.
- .3 The ACAM system shall be centrally controllable, scalable and modular in design, meaning the system can be easily upgraded and or expanded to accommodate additional sites, users, devices, controllers and inputs/outputs as required by the site in the future. The system shall use an open, distributed architecture, where database servers could reside in geographically separate locations.
- .4 The ACAM system shall be a non-proprietary, open-sourced system allowing for integration with a number of different credential readers, door devices, access cards, and other systems (Video Surveillance, Intercommunications, Duress).
- .5 The particular spare capacity and expandability required shall be specified with each individual site based on their projected future needs.
- .6 Approved manufacturers and platforms for Access Control systems include that latest version of:
  - .1 Lenel S2 Netbox
- .7 All ACAM installations shall be done by a fully certified Lenel S2 integrator with support in the Hamilton Area.

## **2.2 ACAM Deployment Strategy**

- .1 As a minimum, the following access points (where applicable) shall be equipped with credential readers, locking devices, door position sensors and request-to-exit devices in order to monitor door held/forced open events, grant/deny access and provide an audit trail of person(s) accessing the door:
  - .1 For Elementary Schools:
    - .1 Main door.
    - .2 Caretaker entrance (near alarm panel).
    - .3 Caretaker rooms where keys are stored.
    - .4 Full-day daycare entrances.
    - .5 Playground access door.
    - .6 Side or Secondary entrances/exits from portables.
    - .7 Kindergarten rooms with access to playground.
    - .8 Main IT Closets.
    - .9 School access connected to city community centres.

## **2.3 ACAM Software Platform**

- .1 The ACAM system shall be an integrated system that utilizes a single, industry-standard relational database management system for the storage and manipulation of related data.
- .2 All defined system data as well as historical information shall be maintained. Customizable user interfaces shall allow management of system information and activity for administrators and operators.
- .3 The software shall provide a variety of functionalities, including but not limited to:
  - .1 Controller (Unit) management, door management, elevator access control management and area/zone management.
  - .2 Control of hardware (readers, sensors, locking devices, annunciators, request-to-exit, remote door release, other system inputs/outputs and integrated systems and devices).
  - .3 Live event monitoring.
  - .4 System functions (event command and control, actions, schedules).
  - .5 Alarm and notification management.
  - .6 Cardholder and cardholder group management, credential management and access rule management. Global cardholder management across multiple facilities and geographic areas.
  - .7 Reporting, including creating custom report templates, incident reports, audit and user activity logs.
  - .8 Queries.
  - .9 System health monitoring.
  - .10 Intrusion device and panel integration.
  - .11 Video surveillance integration.
  - .12 Elevator destination dispatch integration.
  - .13 Capable of SIP intercom device integration for bi-directional communication.
  - .14 Dynamic graphical map viewing.
  - .15 Badge printing and template design creation.
  - .16 Capable of Visitor Management functionality via add-on applications.
  - .17 People counting, area presence tracking, and mustering.
  - .18 Capable of integration with third party systems.
- .4 Day One (1) Software Configuration Requirements
- .5 Graphical User Interface per site
  - .1 The software shall employ a standard Windows graphical user interface (GUI). A mouse and keyboard shall be the primary operator interface with the system. Operator screens shall utilize all standard Windows-style functions such as drop-down menus, context menus, radio buttons, and lists, as appropriate. The interface shall utilize a 'tree structure' similar to Windows Explorer.

- .2 The GUI shall be configurable by the system administrator to control the views and access of each Monitoring Station operator. The monitoring station interface shall be user-customizable. The software shall support the ability of the end user to create a customized application layout for the monitoring station. The monitoring station shall support multiple application layouts that can be assigned to the operators.
  - .3 Access to view or modify system configurations, various features and functionalities shall be privilege based. The software shall allow for the creation and management of various types of user profiles with varying degrees of rights and privileges to view, access or modify the software via the use of login and password requests.
  - .4 The software shall be configured to track the activity of users and maintain a log over a predetermined period of time that is accessible by system administrators with the highest access privileges.
  - .5 System shall be programmed to accommodate automatic locking and unlocking of doors for multiple periods of times during the day based on the operational requirements.
  - .6 The ACAMS shall provide continuous unattended access control and alarm monitoring at specified locations while meeting the technical and functional requirements stated herein.
  - .7 The ACAMS shall grant or deny access or display an alarm within one (1) second of an access attempt or alarm origination. Following a power failure and the restoration of main power, the ACAMS shall revert automatically to normal service status without the need for operator intervention. The system shall restart in the same state as existed before the power interruption.
- .6 Mobile Device Applications
- .1 The system shall be provided with Mobile Applications allowing operators to monitor or administer the system by way of mobile device. The device shall be connected via the phone network and a VPN or via Wi-Fi to the SMS server. The number of Mobile applications required shall be specified by the Client.
  - .2 The Mobile Application shall be configured to provide the following core features:
    - .1 Provide operators with the appropriate privilege, access to tools used for inspecting the software Logs.
    - .2 Provide a collection of tools to monitor events and other objects. Monitoring shall show active events in real time.
    - .3 Provide a collection of tools to manage personnel and shall allow for the following:
      - .4 Create/Update Personnel Records
      - .5 Assign/Remove a card/credential to personnel.
      - .6 Capture an image and associate that image with personnel.
      - .7 Grace personnel, Antipassback Card Reset, Area Lockout Grace, and remove personnel from an Area.

- .7 Graphical Maps Configuration
  - .1 Unless indicated otherwise by the Client, the software shall be configured to utilize graphical maps during implementation.
  - .2 The system shall support an operator-programmable, color graphic map display that:
    - .1 Shows the floor plan, the location of alarm devices, and alarm instructions for a facility.
    - .2 Shall be centralized in the system configuration and displayed on the operators' workstations.
    - .3 Shall allow various maps to be associated with different areas to create a hierarchy of maps.
    - .4 Shall support mapping functionality for access control, video surveillance, intrusion detection, and other external applications integrated with the Access Control system.
  - .3 The graphical maps shall provide the ability to display, monitor the status of, and control all integrated devices, including, but not limited to:
    - .1 Cameras
    - .2 Door status
    - .3 Alarms
    - .4 Intrusion devices
    - .5 Intrusion zones
    - .6 Panic/duress devices
    - .7 System inputs
    - .8 System outputs
    - .9 Intercoms
  - .4 Credential and Cardholder Management
    - .1 The software shall support the configuration and management of credentials, for example access cards and keypad PIN numbers as well as the configuration and management of cardholders and cardholder groups. A user shall be able to add, delete, or modify a credential, cardholder or cardholder group if the user has the appropriate privileges.
    - .2 Custom fields shall be enabled for both cardholders and cardholder groups. Users shall be able to add Custom Fields (user-defined fields) to credentials. Creating a new credential shall be accomplished either manually or automatically.
    - .3 The software shall be configured to allow for the enrollment of a wide range of tenant card types and provide means for preventing the duplication of credentials.
    - .4 Cardholder groups shall enable the grouping of cardholders to facilitate mass changes to system settings. It shall be possible to assign cardholder groups to access rules, thus avoiding the assignment of one cardholder at a time.

- .5 The software shall support a minimum of three (3) credentials (cards) per Personnel record and shall only count Active and/or Expired Cards towards the maximum assignable Cards per Person. Cards designated as Lost, Stolen and Disabled shall not count towards the maximum assignable Cards per Person. The software shall automatically detect and prevent attempts to register an already-registered credential.
- .6 The software shall be configured to allow the creation and management of mobile IDs in the same way as other credentials.
- .7 The software shall be configured to automatically disable Personnel Credentials that have not been used for a specified period of time. The Disable by Inactivity process shall support a user configurable daily scan time.
- .5 System Health Monitoring
  - .1 The System must be configured to generate alarms based on server communication issues, controller A/C power and D/C backup failures, communication faults with devices and/or controllers, power supply failures etc.

## **2.4 ACAM Servers**

- .1 The server shall come complete with operating system and applications software, operator and administrator terminals with appropriate software and fixed magnetic storage media.
- .2 The following requirements are considered minimum only. Exact hardware to be provided shall be dependant on site, system and configuration specific requirements and shall not result in any degradation to the performance of the system.
- .3 S2 Enterprise Netbox server for ACAM is provided by HWDSB.

## **2.5 ACAM Workstations**

- .1 Workstations for monitoring are provided by HWDSB.
- .2 The workstation recommended technical specifications are the following:
  - .1 O/S: Windows 10
  - .2 Processor: Intel Core i7
  - .3 Hard Drive: min 500GB
  - .4 Memory: Min 8GB
  - .5 Network Card: 1GB
  - .6 Video card: dedicated 1GB accelerated video card

## **2.6 Data Gathering Panels (DGP)**

- .1 DGPs shall be capable of using OSDP for reader connectivity.
- .2 Each DGP location shall be provided with a network-based controller with on-board 10/100/1Gb Ethernet ports, using standard RJ-45 connectors. The network ports must support full duplex communications.



- .3 The DGP shall be powered from a low voltage 12VDC power source, within a range of +/- 15%. 12VDC power is used to power the DGP electronics, plus, reader power and RS485 bus power.
- .4 DGPs shall be capable Fire Alarm Interlock whereby lock outputs are controlled directly from a fire alarm input on the board, based on a local dip switch setting for each output. When the fire alarm input is activated, the lock output shall be controlled to the door open state, if its fire alarm dip switch was enabled for that lock. Fire alarm control shall be hard-wired and not dependent on any software or firmware function to operate. Fire alarm functionality shall be tested and listed per UL.
- .5 The DGP shall be housed in a locking 18-gauge steel enclosure, suitable for wall mounting in accordance with UL 294. All cabinet locks shall be keyed alike. The cabinet shall be suitably sized to allow installation of the DGP and associated field wiring. A single, Normally Closed (NC) tamper switch shall be incorporated into the door. There shall be at least 12 knockouts on the enclosure of various sizes to facilitate conduit and wire routing.
- .6 Each rack mount enclosure shall have its own NC tamper switch, incorporated into the body of the enclosure and activated whenever the cover is removed or partially removed.
- .7 Lenel S2 systems shall utilize the following controllers:
  - .1 Mercury LP1502, LP2500 controllers with Mercury SIO modules;
  - .2 S2 Security Netbox Controller with 16 portal licenses model S2-NB16-E2R-WM;
  - .3 S2 Expansion Blade model S2-ACM;
  - .4 S2 I/O boards: S2-OUTP and S2-INP;

## **2.7 Card and Fob Readers**

- .1 Approved manufacturers of card and Fob readers include:
  - .1 HID
  - .2 Schlage
- .2 Approved models of card and fob readers:
  - .1 SIGNO 40, 40K, 20, 20K
  - .2 Schlage MT Series compatible with OSDP
- .3 Card and Fob readers shall simultaneously support (securely read, interpret and authenticate) 13.56MHz and 125Khz contactless credentials and be capable of supporting 2.4GHz mobile devices. The contactless smart card reader shall read unique ID numbers from the card technology. The Contractor is responsible for ensuring any credentials supplied as part of this project are compatible and unique from existing credentials in use.
- .4 Simultaneously support of BLE Mobile Devices, NFC Mobile Devices. The contactless smart card reader shall read credentials from Android and IOS mobile devices.

- .5 Contactless smart card reader shall support the following communications interface options:
  - .1 Bidirectional communication in compliance with v2 of the SIA OSDP (Open Supervised Device Protocol) standard. 4-conductor #22 AWG
  - .2 Wiegand or Clock & Data: 5-conductor #22 AWG
- .6 The multi-technology contactless smart card reader shall be optimally designed for use in access control applications by providing:
  - .1 Unique read selection that enables reading of the Secure Identity Object™ (SIO), standard iCLASS, 125 kHz proximity, or multiple technologies at the same time.
  - .2 Backwards compatibility with legacy 13.56 MHz contactless smart card and 125 kHz proximity access control formats (E.g. 26-bit, 32-bit, 35-bit, 37-bit, 56-bit, and HID Corporate 1000 formats). Compatibility across the product line shall be assured without the need of special programming.
  - .3 Global, off-the-shelf availability.
  - .4 Enables secure access with a mobile device by leveraging standard communication technologies that work with both iOS® and Android™ operating systems. Including validation of support with at minimum 15 different mobile device models.
  - .5 Simultaneously support of BLE Mobile Devices, NFC Mobile Devices and 13.56MHz and 125kHz contactless credentials. Supporting new Mobile applications and existing card populations for seamless migration to a more secure standard.
  - .6 Designed to accept hardware expansion modules that add processing power or communication functionalities, including Bluetooth Low Energy for mobile virtual card communication and OSDP for panel communication.
- .7 No special system modifications are required to read mobile credentials. Existing Wiegand readers can easily be replaced and work with existing access control panel hardware.
- .8 The multi-technology contactless smart card reader shall provide enhanced security technology and features:
  - .1 The multi-technology contactless smart card reader shall be Secure Identity Object™ (SIO) enabled. The multi-technology contactless smart card reader platform shall support the standards-based, device-independent Security Identity Object™ (SIO) portable credential that binds the credential to the physical media to ensure data authenticity and privacy. The SIO shall be able to reside on any number of identity devices, including Mobile ID, and MIFARE DESFire EV1 credentials.
  - .2 The multi-technology contactless smart card reader shall be a certified end-point (TIP Node) within a Trusted Identity Platform™ (TIP) infrastructure. TIP shall provide a scalable, on-demand, secure identity delivery system that validates, registers and provides lifecycle management support for certified trusted end-point multi-technology contactless smart card readers.

- .3 The multi-technology contactless smart card reader shall increase security by narrowing the possibility of unwanted configuration changes and denials of service. The multi-technology contactless smart card reader shall utilize TIP-enabled secure configuration of multi-technology contactless smart card readers with counters and uniquely diversified configuration cards.
- .4 The multi-technology contactless smart card reader shall utilize Secure Element Technology™ to protect keys and cryptographic functions to the international standard Evaluation Assurance Level (EAL) 5+.
- .5 The multi-technology contactless smart card reader shall be configurable to utilize Velocity Checking to provide breach resistance against electronic attacks that invoke multiple improper authentication attempts.
- .9 The multi-technology contactless smart card reader shall enable ease of installation through identical wiring methods as legacy 13.56 and 125 kHz proximity readers.
- .10 The multi-technology contactless smart card reader shall enable backwards compatibility with legacy 13.56 MHz and 125 kHz proximity access control formats (E.g. 26-bit, 32-bit, 35-bit, 37-bit, 56-bit, and HID Corporate 1000 formats).
- .11 The multi-technology contactless smart card reader shall provide universal compatibility with most access control systems by outputting card data in compliance with the SIA AC-01 Wiegand standard.
- .12 Multi-technology contactless smart card reader shall be configurable to provide Clock-and-Data output.
- .13 Multi-technology contactless smart card reader shall be configurable to provide secure, bidirectional communication in compliance with v2 of the SIA OSDP (Open Supervised Device Protocol) standard
- .14 Multi-technology contactless smart card reader shall allow the reader firmware to be upgraded in the field without the need to remove the reader from the wall through the use of factory- provided Programming Cards.
- .15 Multi-technology contactless smart card reader shall allow for secure installation practices through mounting methods utilizing tamper resistant screws.
- .16 Multi-technology contactless smart card reader shall provide the ability to transmit an alarm signal via and integrated optical tamper switch if an attempt is made to remove the reader from the wall.

## **2.8 Access Cards**

- .1 Approved manufacturers of access cards include:
  - .1 HID Prox
- .2 The contactless smart card shall be a passive device, with an operating frequency of 125 KHz proximity interface.

- .3 The card shall support efficient privacy protection to ensure that personally identifiable information or cards identifiers (such as contactless UID, key diversifier) are not accessible and cannot be retrieved by unauthorized parties. To prevent sequence replay or cloning, transmitted secrets or previously transmitted identifiers are not revealed in the clear to the off-card application.

## **2.9 LOCKING DEVICES ELECTRICAL REQUIREMENTS**

### **.1 Electric Strikes**

- .1 Electric strikes shall be capable of accepting both 12VDC and 24VDC.
- .2 All electric strikes shall be tamper resistant.
- .3 In the event of a power failure or building down, electric strike equipped security doors shall fail secure unless otherwise noted. Meaning electric strikes shall always allow for free egress.
- .4 All electric strikes shall have a minimum static strength of 680kg (1500lbs).
- .5 All electric strikes shall have a minimum endurance of 500,000 cycles.
- .6 All electric strikes shall be capable of supporting continuous duty to ensure electric strikes remain unlocked for a programmable length of time without causing damage or failure to the electric strike.

### **.2 Electromagnetic Lock**

- .1 High security override switches shall consist of "Medeco" devices and be tamper protected.
- .2 All override/resets shall be tamper resistant key switches.
- .3 All units shall be tamper resistant and installed with tamperproof screws.
- .4 All units shall be constructed with minimum ¼" extruded aluminum plate.
- .5 All units shall be equipped with LED indication lamps indicating secure and unsecure.
- .6 All units shall be equipped with screen printed reset/override and directional arrows indicating function of corresponding switches.
- .7 Both override and reset switches shall have a switch configuration of SPDT to achieve momentary action.
- .8 Provide a magnetic lock keyswitch override and reset switch in the building CACF room inclusive of keyswitch tie-in to the magnetic lock power supply riser.

## **2.10 DOOR POSITION SWITCHES**

- .1 Approved manufacturers of door position switches include:
- .2 Allegion Schlage
  - .1 Assa Abloy Securitron
  - .2 DormaKaba RCI
- .3 Wiring from the switch shall be enclosed.

- .4 The switch set shall be comprised of a rare earth magnet recess mounted to the door and a DPDT switch recessed mounted to the frame and self locking in wood or metal.
- .5 Loop type shall be: open/closed.

## **2.11 REQUEST-TO-EXIT DEVICES MOTION SENSORS**

- .1 Approved manufacturers of request-to-exit motion sensors include:
  - .1 SDC
  - .2 Interlogix
  - .3 Kantech
- .2 The request-to-exit motion sensor shall utilize infrared technology coupled with digital signal processing to prevent false alarms.
- .3 The device shall incorporate two-form C output relay contacts.
- .4 The unit shall also incorporate an integral local door alarm sounder independently controlled by the security DGP.
- .5 The device shall include capability for easy adjustment of sensor field of view.
- .6 Tamper resistant with tamper switch incorporated for detecting opening of device.
- .7 Approved manufacturers of request-to-exit push buttons include:
  - .1 Camden
  - .2 SDC
  - .3 Assa Abloy
  - .4 Kantech
- .8 The push button assembly shall consist of a heavy-duty blue push button switch and stainless- steel wall plate.
- .9 The switch assemblies shall have sufficient "overplay" to be able to withstand repeated physical pressure.
- .10 The switch shall be DPST type. One pole shall act as an egress input, while the second will interrupt power to the lock.
- .11 The wall plate shall have the word "exit" engraved in it, in six (6) mm (1/4") high red letters and be designed to fit on a standard single gang electrical utility box.

## **2.12 REMOTE DOOR RELEASE PUSH BUTTONS**

- .1 Approved manufacturers of request-to-exit push buttons include:
  - .1 SDC
  - .2 Assa Abloy
  - .3 Allegion Schlage
  - .4 DormaKaba RCI

- .2 The unit shall be mounted on the underside of desks and counters
- .3 The device shall be configured to be a momentary push button.
- .4 The unit shall be SPDT and rated minimum 4 amps @ 28VDC.

## **2.13 POWER SUPPLIES AND BATTERY BACKUPS**

- .1 Approved manufacturers of power supplies include:
  - .1 Altronix
  - .2 SDC
  - .3 DormaKaba
- .2 Provide fully ACAM compatible power supplies with battery backup for all field components. Batteries shall sufficient capacity to support the following security devices for a minimum of 4 (four) hours:
  - .1 Access Control DGPs;
  - .2 Locking devices
  - .3 Card Readers;
  - .4 Request-to-Exit Devices;
  - .5 Panic Buttons;
  - .6 Duress Stations (audible and visual alarms);
- .3 Power supplies are to be located within or wall mounted beside security DGPs as an integral part of the security system riser. All power supplies shall be mounted on minimum ¾" fire retardant plywood backboard.
- .4 Power supply shall provide multiple independently controlled outputs with options for fail safe and fail secure outputs.
- .5 Fuses shall be rated for 3.5A.
- .6 Outputs shall be filtered and electronically rated.
- .7 Power supply shall provide AC fail supervision via form C contacts.
- .8 Power supply shall be capable of fire alarm disconnect (latching or non-latching) that can be applied individually to each of the outputs.
- .9 Refer to Section 9 for Uninterruptable Power Supply (UPS) and Emergency Power requirements.

## **Part 3 Video Surveillance System (Vss)**

### **3.1 OVERVIEW AND SYSTEM ARCHITECTURE**

- .1 The components of the IP video surveillance system include, but are not limited to, IP CCTV camera(s) and their Ethernet data cables connected back to a network point of presence device such as a PoE network switch (provided by HWDSB). The use of analog cameras is not permitted, unless specifically approved in extenuating circumstances when absolutely necessary, in which case they are to be used with encoders. Where cable distance limitations become an issue, PoE extenders are to be utilized with IP cameras. Network Video Recorders (NVR) and storage network drives are connected to the video surveillance security LAN and provide access to consolidated, data storage array/servers. These devices allow a large storage capacity of high-quality images to be recorded and held for extended periods of time. Video management software is incorporated in the server and is required to properly record images and allow for video playback.
- .2 VMS IP devices shall be connected to one or more system servers, via a separate VLAN of the base-building converged network, utilizing a Fast Ethernet 10/100 or 1 GB, TCP/IP network, which manage and store all access control information relating to users and administrators. Workstations (provided by HWDSB) are connected, via the separate VLAN, to the VMS server shall allow administrators to monitor and manage the system.
- .3 The System shall be centrally controllable, scalable and modular in design in that additional cameras, servers, clients workstations, and sites can be added to the system in the future as required.
- .4 The LAN for each site shall be connected to the HWDSB WAN, provided by the Owner, for remote offsite monitoring/control of each site.
- .5 The System shall have the capability of being centrally controllable, scalable and modular in design in that additional cameras, servers, client's workstations and sites can be added to the system in the future as required.
- .6 The VMS shall be a non-proprietary, open-sourced system allowing for integration with a number of different camera manufacturers and integration with other systems (Access Control/Alarm Monitoring, Intercommunications, Duress), preferably those existing at other HWDSB facilities. The VMS shall be based on a true open architecture that shall allow the use of non-proprietary workstations and server hardware, non-proprietary network infrastructure and non-proprietary storage.
- .7 Any and all Power over Ethernet (PoE) enabled devices shall be standardized to PoE 802.3 AF. Those devices that require additional power shall be powered from PoE+ network gear.
- .8 The Video Surveillance system shall be provided with a minimum twenty (20%) percent spare capacity however, the particular spare capacity and expandability requirements shall be specified for each individual site based on their projected future needs.
- .9 The System shall be capable of utilizing acceptable remote client workstations with enterprise licensing capabilities, proportionate to the size and usage of the site.

- .10 Approved manufacturers and platforms for Video Surveillance systems include the latest version of:
  - .1 Lenel S2 NetVR
  - .2 Lenel S2 Magic Monitor
- .11 All VMS installations shall be done by a fully certified Lenel S2 integrator with support in the Hamilton Area.

### **3.2 CAMERA DEPLOYMENT STRATEGY SECONDARY SCHOOLS**

- .1 New and existing sites deployment
  - .1 As a minimum, the following areas and spaces (where applicable) shall be provided with detailed level surveillance coverage, where detailed coverage is defined as coverage that provides details including, but not limited to, facial and body features for the identification of individuals in addition to details of incidents and activities taking place within the target area:
    - .1 Main Lobby/Vestibules.
    - .2 Stairwells.
    - .3 Loading Docks.
  - .2 As a minimum, the following areas and spaces (where applicable) shall be provided with general level surveillance coverage, where general level coverage is defined as coverage that provides an overview of incidents, activities taking place within the target area and the general appearance of person(s) involved:
    - .1 Common Areas/Spaces (Cafeterias).
    - .2 Shipping/Receiving Areas.
    - .3 Building Exterior.
    - .4 Hallways/Corridors.
    - .5 Parking Areas.
  - .3 The following areas shall be provided with general level surveillance coverage but detailed location for cameras shall be coordinated with the client (HWDSB) as it will depend on site specific requirements:
    - .1 Side Entrances/exits.
    - .2 Emergency Exits.
  - .4 The following areas and spaces shall not include video surveillance coverage:
    - .1 Playgrounds.
    - .2 Elevators.
    - .3 Instructional hallways (unless requested based on previous evidence of incidents).
    - .4 Learning Commons.
    - .5 Gyms.
    - .6 Auditoriums.
  - .5 CCTV coverage for Elementary schools and Education Centres shall be evaluated on a project-to-project basis in coordination with the HWDSB designee and as per request.



### **3.3 VIDEO SURVEILLANCE SOFTWARE PLATFORM**

- .1 The Video Surveillance system shall be setup to be simple to learn and intuitive to use by security operators and administration personnel.
- .2 The Software shall allow cameras to be added on a unit-by-unit basis.
- .3 The software shall provide a variety of functionalities, including but not limited to:
  - .1 The software shall function seamlessly with any combination of client and server applications running any of the supported operating systems. For example, a client running Microsoft Windows 7/10/11 shall be able to simultaneously connect to four (4) different servers, each running a different compatible windows operating system.
  - .2 The software shall be capable of running multiple instances of the client application simultaneously on a single workstation for display on multiple monitors. Subject to limitations of commercially available computer workstation hardware, the NetVR software shall support up to twelve (12) simultaneous instances of the client running simultaneously on a single workstation. Multiple monitors shall be configurable on a single workstation, with one (1) client application displayed on each monitor. The client workstation hardware shall require multi-core processors and display adapters to support this functionality. The client workstation be equipped with one (1) CPU core for each instance of the client application to be displayed.
  - .3 The software shall allow authorized users to view video through a web client interface. The web client interface shall allow authorized users to view live video; views recorded video, control pan-tilt zoom (PTZ) cameras, and activate event triggers. The web client interface shall allow connections to multiple servers simultaneously.
  - .4 When operating the web client interface, the server shall automatically transcode the requested video into a JPEG file size consistent with the browser screen resolution before making it available to the browser.
  - .5 The system shall not require the manufacturer to be contacted for a camera on the system to be replaced. The system shall allow users to replace cameras without the need for individual license keys but rather system-wide camera streams.
  - .6 The server software shall run as a service. The server shall not require any application to be running in order to operate.
  - .7 The system shall allow software triggers to be configured, viewed and triggered from a graphical user interface map.
  - .8 The software shall support the use of panoramic lenses on analog or IP cameras. The client software shall de-warp the image for both live and recorded video.

- .4 Day One (1) Software Configuration Requirements
  - .1 Recording and Storage Parameters
  - .2 Provide an NVR to record all cameras at 15fps at full camera resolution for a minimum of 30 days. The cameras will be set to record based on video motion detection. The contractor is responsible to calculate the amount of storage that is required based on 60% motion per day. Live View Parameters:
    - .1 All cameras shall be configured to display live views of camera feeds at minimum 1080p, H.264 and 15 fps.
  - .3 Dynamic Mapping Configuration
    - .1 The Video Surveillance system shall be capable of utilizing dynamic mapping environment which allows the creation of interactive floorplans/renderings to identify cameras and their location on plan, remotely control pan tilt zoom functions, remotely configure camera resolution, frame per second recording rate, camera stream compression, etc.
  - .4 Graphical User Interface
    - .1 The software shall employ a standard Windows graphical user interface (GUI). A mouse and keyboard shall be the primary operator interface with the system. Operator screens shall utilize all standard Windows-style functions such as drop-down menus, context menus, radio buttons, and lists, as appropriate. The interface shall utilize a 'tree structure' similar to Windows Explorer.
    - .2 The GUI shall be configurable by the system administrator to control the views and access of each Monitoring Station operator. The monitoring station interface shall be user-customizable. The software shall support the ability of the end user to create a customized application layout for the monitoring station. The monitoring station shall support multiple application layouts that can be assigned to the operators.
    - .3 Access to view or modify system configurations, various features and functionalities shall be privilege based. The software shall allow for the creation and management of various types of user profiles with varying degrees of rights and privileges to view, access or modify the software via the use of login and password requests.
  - .5 System Health Monitoring
    - .1 The System must be capable and configured to generate alarms and notifications based on camera malfunction, camera tamper, camera stream loss, camera image blocked and storage malfunction.
    - .2 The System must be capable and configured to generate alarms and notification of recording hardware failures.
  - .6 Mobile Device Applications
    - .1 The Security System shall be able to be monitored via the Mobile Security Professional app and shall communicate over any Wi-Fi or cellular network connection.

- .2 The app shall be able to provide the following capabilities:
  - .1 Shall allow for the operation of distributed LenelS2 NetBox access control and NetVR video management systems on iOS or Android devices.
  - .2 Multi-System Control: Includes the ability to switch between separate NetBox or NetVR systems or partitions.
  - .3 SSL Support: Provides encrypted communications between Mobile Security Professional and the NetBox controller.
  - .4 Video Surveillance: Delivers live video and event-based video recording from any VRx or NetVRTM camera.
  - .5 Video Snapshot: Allows sharing of critical images via email or text message.
  - .6 Event Monitoring: Displays event activity and video of interest both real time and recorded.

### **3.4 VIDEO ANALYTICS**

- .1 The video surveillance system shall be capable of executing native or 3rd party video analytics including, but not limited to, forensic investigation capabilities, motion detection (exterior of buildings) and license plate recognition.
- .2 The extent of analytics required shall be defined by site requirements. The system shall be capable of adding and applying analytics on a camera-by-camera basis without the need for hardware or software upgrades.

### **3.5 FIXED CONVENTIONAL, 1800 AND 3600 IP DOME CAMERAS**

- .1 Approved manufacturers and models of cameras include:
  - .1 Axis Communications P3265-LV, P3265-LVE, P3727-PLE, P3827-PVE and M3086-V (Wide Angle applications only - Stairwells). No Exceptions unless is an model updated from the manufacturer.
- .2 Cameras shall be based upon standard components and proven technology using open and published protocols. The camera shall be ONVIF compliant.
- .3 Cameras shall be housed in a dome enclosure/case.
- .4 Cameras shall be capable of providing video streams in minimum HDTV 1080p (1920x1080) resolution at 30 frames per second (fps) using H.264 compression.
- .5 The camera shall meet the following video compression standards:
  - .1 MPEG-4:
  - .2 ISO/IEC 14496-10 AVC (H.264)
- .6 The camera shall meet the following networking standards:
  - .1 IEEE 802.3af (Power over Ethernet)
  - .2 IEEE 802.1X (Authentication)

- .3 IPv4 (RFC 791)
- .4 IPv6 (RFC 2460)
- .5 QoS – DiffServ (RFC 2475)
- .7 The camera shall support the following video resolutions:
  - .1 1280x720 (HDTV 720p)
  - .2 1920x1080 (HDTV 1080p)
  - .3 3072x1728
- .8 The camera shall allow for video to be transported over:
  - .1 HTTP (Unicast)
  - .2 HTTPS (Unicast)
  - .3 RTP (Unicast & Multicast)
  - .4 RTP over RTSP (Unicast)
  - .5 RTP over RTSP over HTTP (Unicast)
  - .6 The camera shall support Quality of Service (QoS) to be able to prioritize traffic.
- .9 The camera shall be equipped with an integrated event functionality, which can be triggered by:
  - .1 External input
  - .2 Video Motion Detection
  - .3 Audio Detection
  - .4 Schedule
  - .5 Camera tampering
  - .6 Local storage full
  - .7 Response to triggers shall include:
    - .8 Notification, using TCP, SMTP or HTTP
    - .9 Image upload, using FTP, SMTP or HTTP
  - .10 Activating external output
  - .11 Recording to local storage
  - .12 The camera shall provide a minimum of 48 MB memory for pre & post alarm recordings.
  - .13 Event functions shall be configurable via the web interface.
- .10 Cameras shall be equipped with Day/Night functionality and remote zoom and focus capabilities.
- .11 Cameras shall use a high-quality IR-sensitive progressive scan megapixel sensor.
- .12 Cameras shall be capable of providing pictures down to 0.06 lux while in night mode (with IR-filter removed) and down to a minimum of 0.4 lux while in day mode (with IR-filter in use).

- .13 Fixed IP cameras may be provided as single-sensor 180° and 360° minimum 3-megapixel or multi- sensor field of vision cameras.
  - .1 Fixed IP 180° cameras shall be considered in the exterior of the buildings (wall mounted). Ensure blind spots typically directly beneath the 180° cameras are addressed. For large areas or for the ability to see greater distances, utilize multi-sensor cameras.
  - .2 Fixed IP 360° cameras shall be considered in the exterior of the buildings (corners) where all views need to be monitored concurrently. Ensure blind spots typically directly beneath the 360° cameras are addressed. For large areas or for the ability to see greater distances, utilize multi-sensor cameras.
- .14 Cameras shall be manufactured with a tamper resistant body.
- .15 The camera shall support the following security measures:
  - .1 Support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
  - .2 Support IEEE 802.1X authentication.
  - .3 Provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
  - .4 Restrict access to the built-in web server by usernames and passwords at three different levels.
  - .5 HTTPS must be enabled on all cameras.
  - .6 API support
  - .7 The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
- .16 The camera shall support the following power requirements:
  - .1 Power over Ethernet according to IEEE 802.3af - Class 2.
- .17 Outdoor cameras shall be manufactured with an all-metal vandal resistant body, and support operation between -30°C to +55°C.

### **3.6 NETWORK VIDEO RECORDERS**

- .1 Exact network video specifications shall be dependant on site specific requirements and the size of the new system. All network video recording/archiving equipment shall be provided as per VMS manufacturer recommendations in order to ensure optimal system performance.
- .2 Archivers shall be provided with minimum RAID 5 configuration.
- .3 Approved manufacturers and models of Video Management Systems:
  - .1 Lenel S2 NetVR 125 series (for systems under 64 cameras).
  - .2 Lenel S2 NetVR 700 (for systems under 128 cameras).

### **3.7 VIDEO SURVEILLANCE WORKSTATIONS (PROVIDED BY HWDSB)**

- .1 For the Video Surveillance system, the client workstation hardware shall be capable of streaming a minimum of eight (16) live or recorded camera streams per desk monitor simultaneously on all desk monitors at 1080p, 15 frames per second (fps) without any degradation in performance or latency/lag exceeding 1 second.
- .2 The Magic Monitor software and client monitoring systems shall be configured for principals with all hardware provided by HWDSB. No other staff shall have access to Magic Monitor (MM) unless is coordinated with HWDSB security management.
- .3 Workstation minimum specifications:
  - .1 Processor: Intel® Core™ i7 or better
  - .2 RAM: 16 GB of RAM or better
  - .3 Storage 1 : 500GB HDD with 7200 rpm
  - .4 Storage 2: 120 GB Solid State Drive for OS and Security system applications
  - .5 Network: GbE network interface card
  - .6 Graphics Card: NVIDIA® QUADRO K620 2 GB video card
  - .7 Keyboard and optical mouse

## **Part 4 Intrusion System**

### **4.1 OVERVIEW AND SYSTEM ARCHITECTURE**

- .1 The intrusion alarm system shall be an IP based system consisting of controllers, keypads, sensors and interface modules for integration with the Lenel S2 ACAM system and communication modules for 3rd party monitoring.
- .2 The intrusion alarm system shall be integrated with the Fire Alarm Monitoring and conform with CAN/ULC-S302-14 Standard for the Installation, Inspection and Testing of Intrusion Alarm Systems and CAN/ULC-S301-09 Standard for Signal Receiving Centre Burglar Alarm Systems and Operations.
- .3 Glass break monitoring sensors shall be used to detect unauthorized glass breakage.
- .4 Integration with the S2 Security System shall be utilized for intrusion zone activation/deactivation through card reader keypads and motion detection from cameras.
- .5 All alarms generated shall be monitored by the preferred 3rd party alarm monitoring vendor via redundant communication as per the following:
  - .1 Primary is fax link via copper (telephone line).
  - .2 Secondary link to be T-Link (Ethernet)
- .6 The intrusion system shall be provided with Ethernet cards and other equipment as required to achieve the required communication.
- .7 The intrusion system shall be interfaced with BAS for light controls via motion detectors. Refer to section 9 for more details.

- .8 Approved manufacturers and platforms for the Intrusion system shall:

- .1 DSC PowerSeries Neo

#### **4.2 INTRUSION DEPLOYMENT STRATEGY**

- .1 As a minimum, the following areas and spaces (where applicable) shall be provided with intrusion sensors and door contacts (tied to the intrusion system). The intrusion zones shall be provided in zones as per the following:

- .2 Intrusion Alarm Zones which includes:

- .1 Main Lobby Entrances and Vestibules – All Locations;
    - .2 Side Entrances/Exits – All Locations;
    - .3 IT Rooms – All Locations;

- .2 Fire Alarm shall be installed on a separate partition.

- .3 Other locations where glass-break/motion sensors are to be provided include the following:

- .1 All rooms that have window openings such as classrooms or offices located on the ground floor. The motion detectors shall be limited to areas where possible intruders could be detected and coordinated on a site-per-site basis with the client.

#### **4.3 INTRUSION DATA GATHERING PANELS (IGP)**

- .1 The intrusion data gathering panels shall meet the following minimum specifications:

- .1 8 on board zones
  - .2 Expandable to 32 wireless and hardwired zones
  - .3 2 PGM outputs: expandable to 38
  - .4 Connect up to 8 supervised keypads with keypad zones
  - .5 4 partitions
  - .6 500 event buffer
  - .7 72 user codes
  - .8 Approved manufacturer:

- .1 DSC PowerSeries Neo Control Panel model HS2032.

- .2 The intrusion panel shall be equipped with communication modules capable of panel remote uploading/downloading via Internet

- .1 Programmable via DLS 5 or keypad
    - .2 Supervision heartbeat via Internet
    - .3 128 Bit AES Encryption
    - .4 Full event reporting
    - .5 SIA and Contact ID protocol
    - .6 Approved Manufacturer:

- .1 DSC PowerSeries Neo Internet Security Alarm Communicator model TL280

#### **4.4 INTRUSION MOTION AND GLASS BREAK SENSORS**

- .1 The Intrusion Motion and Glass Break sensors shall meet the following minimum specifications:
  - .1 Glass break detection and motion detection in one housing
  - .2 360-degree coverage
  - .3 Separate relay for motion detection and glassbreak
  - .4 Approved Manufacturer:
    - .1 Bravo 5GB – Ceiling Mount PIR and Glassbreak Detector

### **Part 5 Intercommunications**

#### **5.1 OVERVIEW AND SYSTEM ARCHITECTURE**

- .1 The intercommunication system is comprised of door substations and master stations that provide two-way voice communication between the security personnel and the users and are generally used for communicating directly with the security in order to obtain access to a secured door or for reporting an emergency.
- .2 When an intercom station is activated by a user, the master station will ring and a designated staff will answer the call and handle the situation accordingly. In the case of video intercoms, staff will have the ability of viewing the user at the substation through the security computer monitor via the video camera installed at the substation.
- .3 Intercommunication systems shall be analog with capacity to expand up to four (4) substations connected to the master stations.
- .4 The security intercom system shall be designed for security applications and provide reliable and intelligible voice communication between Master Stations and Sub-stations. A Master Station shall be defined as a station that can selectively dial any other Master Station or Sub-station in the system. A Sub-station shall be defined as a station that calls in to a pre-programmed Master Station or group of Master Stations by pressing and releasing a call button.

#### **5.2 INTERCOM DEPLOYMENT STRATEGY ELEMENTARY SCHOOLS ONLY**

- .1 Intercom door substations shall be provided at the following locations:
  - .1 Main building entrances (including accessible entrances).
  - .2 Daycare Centre entrances (including accessible entrances).
  - .3 Full day childcare main entrance.

#### **5.3 DOOR SUBSTATIONS**

- .1 Approved manufacturers of intercoms include:
  - .1 Aiphone.
- .2 Each Intercom substation shall be equipped with microphone, camera, speaker and in-use LED, all housed in one unit with configurable front pushbutton(s).



- .3 Substations may be available as: desktop (with or without display), wall mount (flush or recessed), single gang or double gang with no adapters required, based on site specific requirements.
- .4 The intercom substations shall be installed at OBC approved heights (between 900-1100mm).
- .5 The intercom sub-station with integral video camera shall have the following minimum requirements:
  - .1 Tamper/Weather resistant stanchion
  - .2 Integrated IP video camera
  - .3 Call button
  - .4 Speaker
  - .5 The substation shall provide an integral 1 MP IP color camera.
  - .6 Imager: ¼ inch CMOS, 1 MP
  - .7 Adjustment angle: 30 degree vertical
  - .8 Inputs: 3 floating contact inputs
  - .9 Outputs: 2 1 A relay contact outputs
  - .10 Operating and storage temperature: –13°F to +122°F (–25 °C to +50 °C).
  - .11 Call-In Time-Out Function
  - .12 The programmable Call-in Time-out function shall automatically terminate a call-in from “Normal” priority Sub-stations after a specific time if the call is not answered. The time-out period shall be programmable in one-minute increments from one to ninety- nine minutes.
- .6 Conversation Time-Out Function
  - .1 The programmable Conversation Time-Out function shall automatically terminate intercom conversations after a pre-programmed duration, programmable in ten second increments from ten to nine hundred and ninety seconds. When the limited time is reached, a warning signal tone shall be transmitted to both the calling and called parties to terminate the conversation. The Conversation Time-Out shall not apply to “Emergency Conference”, “Outside-Line Telephone Conversation” or “Emergency Priority Sub-Station Calls”.
- .7 Conversation Modes
  - .1 Between two Master Stations shall be PTT if both handsets are on-hook. Communication between a Master Station and a Sub-station shall be PTT if the Master Station handset is off-hook and PTT if the Master Station handset is on-hook.
  - .2 Calling Party Display Function

- .3 Sub-Station shall display the 6-digit number or 8-character name of one of up to 64 calling stations. When the Master Station simultaneously receives calls from two or more stations, the station with the highest priority shall be displayed, and other waiting stations shall be displayed in order of priority as the [REDIAL] key is pressed. The display priority shall be displayed in the following order: Emergency Conference calls, Emergency priority Sub-station calls, Incoming Outside Telephone Line calls, "Normal" priority Sub-station calls and Master Station calls.
- .8 Call Forwarding Function
  - .1 The Call Forwarding function shall allow incoming calls to be automatically forwarded to another receiving Master Station by registering the receiving station number at the original station (forwarding station) or at the destination receiving station (see Remote Call Forwarding). Call Forwarding shall be enabled and cancelled at the original station by a simple key sequence. After enabled, the registered receiving station number shall be displayed. If the designated receiving station is also registered for a Call Forwarding- related function, calls shall not be forwarded from that receiving station.
- .9 Time-Based Call Forwarding Function
  - .1 The Time-Based Call Forwarding function shall allow incoming calls to be automatically forwarded to another receiving Master Station during a pre-programmed daily time period. During the transfer interval, the registered receiving station number shall be displayed on the original station's display panel to indicate that the original station is in Time-Based Call Forwarding mode. The designated receiving station can directly call the original station without interference from the call forwarding function. If the designated receiving station is also registered for a Call Forwarding-related function, calls shall not be forwarded from that receiving station.
- .10 No-Answer Call Forwarding Function
  - .1 The No-Answer Call Forwarding function shall automatically reroute calls to a Master Station to a designated receiving station if the called party does not respond within a preset period of time, programmable from one to ninety-nine seconds in one second intervals. When several calls are simultaneously made to the original station, the original station shall begin its time count upon receiving the first call and then forward all waiting stations when the set interval time elapses. The designated receiving station can directly call the original station without interference from the No-Answer Call Forwarding function. When the designated receiving station is also registered for No- Answer Call Forwarding, the call shall be further rerouted to the second station. When the designated receiving station is busy, the original station continues to be called. The No-Answer Call Forwarding function shall be disabled when the designated receiving station has already been registered for Call Forwarding. The No-Answer Call Forwarding function does not interfere with a Sub-station call to a designated Group. Call representative station that is registered for No-Answer Call Forwarding. (The group call designation shall be given priority.)

## **5.4 MASTER STATIONS**

- .1 Approved manufacturers of intercoms master stations include:
  - .1 Aiphone.
- .2 A master station shall include the following back light controls:
  - .1 Dialing button 0-9
  - .2 “T”-button
  - .3 “X”-button
  - .4 Scroll/volume Buttons
  - .5 Up/down buttons
  - .6 “Enter, Menu- button
  - .7 Monitor: 3.5-inch (89 mm) color LCD (where required)
- .3 The master station shall also provide a large graphic LCD-display with minimum 8 lines x 14 characters, a single line 6-character alphanumeric display or minimum 3.5 inch 320 x 240 pixel TFT color monitor depending on selected model. The master station shall incorporate ergonomic design, wall mount or desktop.
- .4 All master stations shall have a “handset function” enabling user to switch from loud speaking operation to handset mode by simply lifting station and placing to ear (exception: desktop models with gooseneck microphone).
- .5 Intercom Video Master Station shall come with a video monitor with the following specifications as required:
  - .1 If a call is received from a video sub-station intercom, you can hear audio and if that door station has a camera, you can see image.
  - .2 Press OFF button to end. Call also ends automatically when set communication end time is reached.
  - .3 If you press TALK button while monitoring, hands-free communication mode starts with that sub-station.
- .6 As an option, a two input / output plug in board shall be available in addition to the contact closures and inputs found on various models of intercom station.
- .7 Firmware/feature upgrades shall be made available via download through the intercom server over the IP network. No local modification on the station shall be required.
- .8 The minimum frequency range shall be 200-16000Hz.

## **Part 6 System Monitoring and Control**

### **6.1 MONITORING REQUIREMENTS**

- .1 Live view monitoring for Video Surveillance is restricted to principals at each school.
- .2 Monitoring and control of all Video and ACAM is restricted to designated HWDSB Staff.
- .3 3rd party alarm monitoring is required for installations that include Intrusion Alarm systems and Fire Alarm.

## **6.2 MOBILE AND BROWSER-BASED MONITORING REQUIREMENTS**

- .1 The LenelS2 Mobile Security Platform App shall be utilized to communicate with the security systems over the Security System's dedicated Wi-Fi network connection or through cellular data.
- .2 Refer to latest mobile compatibility list to verify supported/patched OS version numbers. Supported devices include the following:
  - .1 Apple devices running iOS 12.0 or later
  - .2 Android devices 8.0 or later
- .3 The following core functionalities shall be required for the Video Surveillance:
  - .1 View live and recorded video from the Video Surveillance System
  - .2 Including monitoring of video associated with access control and panic alarms.

## **Part 7 System Integration**

### **7.1 INTRUSION AND ACAM SYSTEM**

- .1 Card reader keypads shall be utilized as Intrusion Alarm Keypads (two in total) via the access control system. There are to be a minimum of 2 partitions on the system: 1 partition for the intrusion alarms of the school and 1 partition for systems (fire, trouble, supervisory, no heat signal, and sump pump). Provide sufficient inputs as required to monitor the zones. Each of the two (2) keypads can activate/deactivate either or both of other zones/partitions.
- .2 The intrusion alarm system shall be interfaced with the S2 Security Management System via software integration or I/Os to receive alarms from the S2 Security Management System. Door alarms and video motion detection alarms from the S2 Security System shall generate intrusion alarms on the DSC Neo System. The S2 Security Management System shall integrate with the DSC Intrusion System to allow for codes from the card reader keypad to activate/deactivate intrusion alarm zones.
- .3 The intrusion alarm system shall sound audible alarms (security siren) throughout the facility when an intrusion zone is in alarm.

### **7.2 INTRUSION AND BAS SYSTEM**

- .1 Interface the intrusion alarm system with the BAS System to send armed and disarmed status of the zones/building to a Building Automation system input.
- .2 Interface the intrusion alarm system with the BAS System to enable activation of intrusion alarms to turn on designated lights.

### **7.3 ACAM AND VIDEO SURVEILLANCE**

- .1 The following describes the software level integration requirements between the access control/alarm monitoring system and the video surveillance system.
- .2 Communication shall be established between the access control servers and the video surveillance system servers.

- .3 If redundancy is provided, both the access control primary and redundant (if applicable) servers shall be interfaced to both the video primary and redundant (if applicable) video storage, such that failures of the access control or surveillance systems shall not result in disruption to the integration between systems.
- .4 The following data messages shall be transmitted to the video surveillance system via the interface of every access data gathering panel alarm point and status point with the video surveillance system:
  - .1 Display the camera on monitor specified monitor.
  - .2 Instruct the camera to record at a specified frame rate.
  - .3 Assign unique video segment identifier, set segment start flag.
  - .4 Upon acknowledgement or clearing of event, set camera to normal view parameters and end video segment.
- .5 All messages shall be transmitted and received in an event-based manner.
- .6 A communication validation function that regularly tests the integration for proper operation shall be incorporated into the access control and video surveillance system interface. A scheduled test command shall be sent to the video surveillance system in order to be validated.
- .7 The video surveillance system shall return an acknowledgement or similar message to indicate the access control command was received and executed.
- .8 Communication failure shall be reported when any command sent from the access control server system does not receive a corresponding acknowledgement from the video surveillance system.
- .9 If movement is detected by a camera configured to alarm on motion, the video surveillance system shall be integrated with such that, at a minimum, the following data messages shall be transmitted to the access control system:
  - .1 Transfer emergency signal to the access control and alarm monitoring system for annunciation on designated user interfaces.
  - .2 Activate specified local audible alarms within area.
  - .3 Deactivate specified card readers within area.
  - .4 Display access control dynamic map of immediate area on a specified monitor.
  - .5 Terminate all emergency actions upon acknowledgement or clearance of event at the access control system workstation.
- .10 A similar acknowledgement or message shall be returned by the video surveillance system to indicate that the access control command was received and executed.
- .11 Communication failure shall be reported when any command sent from the access control server system does not receive a corresponding acknowledgement from the video surveillance system.

#### **7.4 ACAM AND INTERCOMMUNICATIONS**

- .1 At each intercommunication point, the access control system shall be integrated such that the intercom substation shall be capable of generating a notification or alarm on the access control user interface upon activation and allow for remote release of ACAM door designated to the intercom.

#### **7.5 ACAM AND AUTOMATIC DOOR OPERATORS**

- .1 Automated door operator pushbuttons and card readers shall be provided on the public or non- secure side of an access-controlled door with barrier free accessibility.
- .2 Automated door operator pushbutton and request-to-exit device shall be provided on the secure side of an access-controlled door with barrier free accessibility.
- .3 Access control points requiring barrier-free accessibility shall be equipped such that automatic door operator buttons are provided at both sides of the door, a credential reader on the unsecure side of the door and a request-to-exit device on the secure side of the door.
- .4 The following sequence of operation shall occur to gain entry to the secured space:
  - .1 When an access card without the proper credentials is presented to the credential reader, the door shall remain secure and the automated door operator pushbutton shall not be capable of opening the door.
  - .2 If an access card with the proper credentials is presented to the reader, the locking device shall be released and the door contact shall be shunted to allow free ingress. The automated door operator pushbutton shall be capable of opening the door for a programmable amount of time before the locking device is engaged and the door is secured.
  - .3 The contact connecting the door operator pushbutton to the motor assembly shall only be closed upon the presentation of a valid access credential to the reader. Once the contact has been closed, it shall open when the locking device re-secures.
- .5 The following sequence of operation shall occur to leave the secured area and enter into public/non-secured space:
  - .1 The user approaches the point of free egress and presses the pushbutton request to exit.
  - .2 The locking device is temporarily defeated, the door contact is shunted and the normally open contact connecting the automated door operator pushbutton to the door opener assembly is closed. The automated door operator pushbutton shall be capable of opening the door for a programmable amount of time before the lock is engaged and the door is secured.

## **Part 8 Power Management and Backup**

### **8.1 UNINTERRUPTIBLE POWER SUPPLIES**

- .1 Uninterruptible Power Supplies (UPS) shall be provided for designated security equipment to ensure that equipment connected to the primary power source and UPS will continue to function in the event of primary power failure. UPS units shall be sized to supply a constant supply of power for the duration of time that is required for the backup or emergency generators to be turned on.
- .2 The following equipment shall be fed from local UPS units where centralized building UPS power is not provided:
  - .1 Video and Access Control System servers.
  - .2 Security Rack Mounted Equipment.
  - .3 Security network equipment.
  - .4 Security workstations and monitors.
- .3 Equipment that is rack-mounted shall be fed from rack-mounted UPS units housed within the same rack.
- .4 For all security equipment loads UPS units shall be sized to provide a minimum of twenty (20) minutes of back up power.
- .5 Electromagnetic lock power supplies shall not be UPS power protected as electromagnetic locks are fail-safe devices and are meant to be unlocked during an emergency to allow for free egress.

### **8.2 EMERGENCY POWER**

- .1 Where building emergency power generator is available, all security equipment loads shall be fed from emergency power and further backed up with UPS to prevent disruptions to security equipment operation when primary power fails.

## **Part 9 Infrastructure**

### **9.1 NETWORK CABLING AND PATCH PANELS**

- .1 Hamilton-Wentworth District School Board's Cable Infrastructure requires an end-to-end CommScope AMP cabling system for copper (category 6) and fiber (OM3). Any cabling products outside this list must be preapproved in writing by HWDSB.
- .2 The cabling system must be installed by a ND&I with CommScope and backed by a CommScope AMP Netconnect 25-year System Warranty. The CommScope System Warranty shall be facilitated by the contractor and be established between HWDSB and CommScope. No third-party certifications or third-party warranties are allowed.

- .3 Provide CommScope manufacturer products (where applicable for this project) as named in individual articles in the below part list and at [www.commscope.com](http://www.commscope.com) if not listed:

- .4 Where required, use Solid copper, 24 AWG, FT6 Plenum ,100 balanced twisted-pair (UTP)

Part Number	Description Code	Description
TE620P-BLRB	CMP UTP 4/23 C6 1K'	Copper Twisted Pair Cable, Category 6, unshielded, 4-pair, blue
TE620P-WTRB	CMP UTP 4/23 C6 1K'	Copper Twisted Pair Cable, Category 6, 4-pair, gray, unshielded, 300 m
1375055-2	JACK,SL110,RJ45,CAT6,BLK	JACK,SL110,RJ45,CAT6,BLK
1375055-4	JACK,SL110,RJ45,CAT6,GRY	JACK,SL110,RJ45,CAT6,GRY
1375055-6	JACK,SL110,RJ45,CAT6,BLU	JACK,SL110,RJ45,CAT6,BLU
1375055-3	JACK,SL110,RJ45,CAT6,WHT	JACK,SL110,RJ45,CAT6,WHT
1375055-7	JACK,SL110,RJ45,CAT6,RED	JACK,SL110,RJ45,CAT6,RED
1-1375055-0	JACK,SL110,RJ45,CAT6,VIOLET	JACK,SL110,RJ45,CAT6,VIOLET
1375055-9	JACK SL110 RJ45, CAT6-JACK-GREEN	JACK SL110 RJ45, CAT6-JACK-GREEN
1933308-1	48PT SHLDHSG FRTLOAD, MM	RJ45 Modular Patch Panel, shielded, front-load 48 port
1933307-1	24PT SHLDHSG FRTLOAD, MM	RJ45 Modular Patch Panel, shielded, front-load 24 port
558088-1	FCEPLTE KIT,4PORT,110CONN,ALMO	AMP NETCONNECT® Faceplate Kit, 4 ports, light almond
557505-3	FCEPLTE KIT,2PORT,110 JK,WHITE	AMP NETCONNECT® Faceplate Kit, 1-gang, 2 ports, white
TCPC-6RUVB-BL02	Cat6 Patch Cord	Cat6 Patch Cord, T568B, Blue 2ft
TCPC-6RUVB-BL20	Cat6 Patch Cord	Cat6 Patch Cord, T568B, Blue 20ft
TCPC-6RUVB-BL25	Cat6 Patch Cord	Cat6 Patch Cord, T568B, Blue 25ft
TCPC-6RUVB-RD02	Cat6 Patch Cord	Cat6 Patch Cord, T568B, Red 2ft
TCPC-6RUVB-RD03	Cat6 Patch Cord	Cat6 Patch Cord, T568B, Red 3ft
TCPC-6RUVB-RD05	Cat6 Patch Cord	Cat6 Patch Cord, T568B, Red 5ft
TCPC-6RUVB-RD07	Cat6 Patch Cord	Cat6 Patch Cord, T568B, Red 7ft
TCPC-6RUVB-RD10	Cat6 Patch Cord	Cat6 Patch Cord, T568B, Red 10ft
TCPC-6RUVB-VT02	Cat6 Patch Cord	Cat6 Patch Cord, T568B, Violet 2ft
TCPC-6RUVB-VT15	Cat6 Patch Cord	Cat6 Patch Cord, T568B, Violet 15ft

Category 6 cables with four individually twisted-pairs. Manufacturer Part CS37P.

- .5 Where required, modular jacks shall be SL110 Series Modular Jack, RJ45, category 6, T568A/T568B, unshielded, without dust cover, green.
- .6 Patch cords used at the network rack and at the camera shall be AMP NETCONNECT Category 6, 24 AWG, 4-pair assemblies' factory-assembled by CommScope.
- .7 Include for 10 feet of slack for each camera patch chord.
- .8 Provide patch panel(s) for each network cabinet/rack as noted in Security drawings. The patch panel shall be rack mountable, 8-pin modular to insulation displacement connector (IDC) meeting Category 6 performance standards and pinned to T568 standards. Provide green modular jacks for IP cameras.

## 9.2 CONDUITS

- .1 Security cabling is not permitted to be exposed. For existing sites, all security cabling not concealed behind finished walls or ceilings shall be enclosed in E.M.T conduit. For new sites, all security cabling shall be enclosed in E.M.T conduit.
- .2 Conceal all conduits except in equipment rooms, unfinished area, and where specifically noted. Flush mount all devices, starters, etc., in finished areas. Install all exposed conduits parallel to building walls and partitions.



- .3 All cabling runs must be in minimum nineteen (21) mm E.M.T conduit to ensure the security and integrity of the security system cabling. Conduit fill shall not exceed sixty percent (60%) fill.
- .4 Where E.M.T conduit is to be exposed indoors, conduit shall be mounted 2.4m (8'-0") above the finished floor.
- .5 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .6 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .7 Run parallel or perpendicular to building lines.
- .8 Run conduits in flanged portion of structural steel. Do not pass conduits through structural members except as indicated.
- .9 Group conduits wherever possible on suspended surface channels.
- .10 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.
- .11 Vertical conduits must be supported at each floor slab and at the top and bottom of each riser.
- .12 Conduits must be supported from building structure. Provide independent unistrut under obstructions such as ductwork for support as required. Support unistrut from structural members. Do not secure to underside of metal pan roof deck.
- .13 Maintain continuity of ground through all connection points. Use sealer lubricant on all threaded connections embedded in concrete, buried in ground or exposed outdoors.
- .14 Leave all conduit systems finished complete with outlet boxes, coverplates, bushings, caps, nylon fish wire, etc. Provide bushings for all sleeves.

### **9.3 LOW VOLTAGE SECURITY CABLES (NOT NETWORK CABLING)**

- .1 All security low voltage and network cabling shall be provided as per security equipment manufacturer's requirements and recommendations.
- .2 Cabling that is installed in non-plenum rated areas and/or installed completely in conduit shall be FT4 or better.
- .3 Cabling that is installed in plenum rated areas and/or not completely installed in conduit shall be FT6 or better. Security system device manufacturer recommendations shall be consulted when determining any additional cabling requirements.
- .4 Conductor colour coding for multi-conductor cabling shall be employed.
- .5 Where required, cabling shall be shielded.
- .6 Where required, cabling shall be outdoor rated.
- .7 All cabling shall be labelled with a mechanically produced and machine printed labels end-to-end at each termination point. All cabling near floor entries and demising walls shall be provided with labels.

- .8 Pulling Cables:
  - .1 Pulling cables are used to pull cabling through conduits.
  - .2 Pulling cables shall be polypropylene and of a strength suitable for tension to be pulled.
  - .3 Pull string shall be replaced in all conduit.
- .9 Cable Support:
  - .1 Ceiling routed free-running cables shall be routed tightly to the underslab of appropriate harnesses and cable supports at a minimum distance of six (6) feet.
  - .2 Harnesses that are to support cabling shall ensure that the entire mass of the cables and the harness is self-supporting and that no weight may be transferred to any other existing fixture or structure in the ceiling space.
- .10 So as to not disturb or disrupt any system, it is important to employ extreme caution when routing cables in the termination rooms, especially if the areas have active or shared equipment.

#### **9.4 FIRE STOPPING**

- .1 For all penetrations through fire separations required to have a fire resistance rating, use firestop systems with an F rating not less than the fire resistance rating for the fire separation. This includes the sealing of any sleeves provided for future uses. Provide an FT rating where required by the Ontario Building Code. For all penetrations through a Service Room floor, provide a minimum W rating - Class 1 in addition to the fire resistance rating.
- .2 All firestopping must be thoroughly reviewed by the Technical Representative of the systems manufacturer on site before any firestopping is concealed and submit a report of compliance with the rating requirements. Technical Representative to complete 3 destructive tests to confirm compliance with ULC listing, minimum one floor test and one wall test, third test to be Contractor's choice. Contractor to replace fire stopping system after destructive test has been completed. Submit a copy of the report to the Consultant. Report to include as a minimum, confirmation fire stopping shop drawings were used during review, locations where destructive testing was completed, confirmation all fire stopping locations were reviewed and installed systems meet the manufacturer requirements.
- .3 Provide instruction wall labels on both sides of wall for all thru-wall penetrations using FlameStopper or equivalent. Locate adjacent to penetration as required to be visible from standing position.
- .4 All fire stopping shall meet the requirements of ULC with regards to fire separation and type of assembly.
- .5 All empty conduits shall be sealed at both ends.

## **9.5 SECURITY ENCLOSURES (ACAM & INTRUSION)**

- .1 Equipment cabinets shall be provided to house security equipment control system component such as power supplies, control power transformers and auxiliary relays.
- .2 Equipment cabinets shall be constructed of code gauge steel and finished on all surfaces with rust inhibiting prime coat and two coats of flat medium gray enamel paint. Panel shall contain hinged door and flush mounted lock and latch. Panel depth shall suit the site condition.
- .3 Coordinate installation of equipment cabinets with millwork construction with respect to dimensions, installation and accessibility. Full accessibility must be maintained as required by the Ontario Electric Safety Code.
- .4 Enclosures shall be neatly dressed, free of dirt and debris and provided with cable management utilizing Velcro ties.
- .5 All cabinets, enclosures, racks and housings having doors or removable covers and containing terminals, P/C hardware or their power supplies, shall be provided with cover operated, corrosion resistant, tamper switch devices connected and monitored from the ACAM system. Tamper devices shall be arranged to actuate an alarm signal when the door or covers are moved as little as 1 cm (3/8") from its normally closed position.
- .6 All controls which affect unit sensitivity shall be located inside the tamper resistant enclosure.
- .7 Provide high security key locks or key operated cabinet switches.
- .8 Tamper switch unit shall remain inaccessible until the switch is activated and shall have concealed mounting hardware so that its location cannot be visually detected from the exterior of the enclosure.
- .9 The switches shall always remain under supervision, whether or not their circuits are in the authorized access or secure modes.

## **9.6 EQUIPMENT RACKS (WALL OR FLOOR STANDING RACKS)**

- .1 All security equipment racks shall have a minimum of twenty five percent (25%) free space in addition to all security equipment and components installed within. Specific Rack Units and Size shall be coordinated and specified depending on site requirements and number of headend devices.
- .2 Rack depth shall be designed according to headend equipment which includes network switches, server (NVR) and UPS units.
- .3 All racks shall be provided with four adjustable rack levelling feet heavy duty 100mm (4") wheels, and wire and cable entrances protected by rubber edging. Racks shall include internal mounting rails and be of steel panel construction.
- .4 Panel rails shall be EIA standard 475mm (19") with door and lock drawers, slides, shelves and turrets as required.
- .5 All power supplies shall be provided with a metal outlet raceway complete with colour coded outlets.

- .6 Provide a metal outlet raceway with colour coded outlets wired to three 15A, 120V power supplies. Install internal 15A breaker protection circuits and receptacles if required.
- .7 If heat dissipation is required for specific racks, provide cooling fans and filters.
- .8 All racks shall be provided with louvers and ventilation apertures located on the top, bottom, sides and back of the racks for convection ventilation.
- .9 Rack panel installation shall be plug-in type terminal blocks with barriers and screw type terminals.
- .10 Velcro ties shall be utilized to manage all cabling within racks.

## **Part 10 Cyber Security**

### **10.1 HWDSB CYBER SECURITY STANDARDS, BEST PRACTICES AND POLICIES**

- .1 Incident Response Plan (IRP):
  - .1 HWDSB maintains a robust IRP that outlines procedures and steps to be taken in the event of a security breach. The IRP covers key components such as preparation, identification, containment, eradication, recovery, and lessons learned. We are very active in updating the plan to ensure its effectiveness.
- .2 Asset/Identity Management:
  - .1 HWDSB maintains an inventory of all devices and systems within the organization. We enforce strict role-based access controls to limit user privileges and prevent unauthorized access, adhering to standard zero trust procedures. Multi-factor authentication (MFA) is implemented wherever possible.
- .3 Network/Endpoint Security:
  - .1 Our network is protected by Palo Alto firewalls, Microsoft intrusion detection/prevention systems, and regular vulnerability assessments. Logging, alerting, and investigation (manual and automated) is done through our Sentinel SIEM solution. We monitor network traffic for anomalies and respond promptly to any suspicious activity. Network integrity is protected through measures like network segregation and segmentation for internal, guest, etc... access. Endpoints are secured through an in-depth Microsoft Defender implementation.
  - .2 HWDSB leverages Microsoft Defender CASB and Purview to review and monitor traffic and usage and respond to cloud-based threats and alerts.
- .4 Data Encryption:
  - .1 Sensitive data is encrypted both in transit and at rest using methods such as TLS and IPsec, as well as the standard Microsoft BitLocker and DM-Crypt. We follow Microsoft best practices for securing local data and backups.

- .5 Vendor Risk Management:
  - .1 We assess and manage the cybersecurity risks associated with third-party vendors. Contracts include security requirements and compliance clauses. HWDSB maintains a privacy assessment when initiating work with third parties. Remote access is managed through our vendor access policy which provides full visibility and limits use of HWDSB resources.
- .6 Security Audits and Assessments:
  - .1 Independent third-party audits, assessments, and penetration testing regularly validates our security controls. Findings are addressed promptly to improve our security posture.
- .7 Training, Incident Reporting, and Communication:
  - .1 All employees undergo regular security awareness training to understand their roles and responsibilities in maintaining a secure environment. Training includes topics such as phishing awareness, password hygiene, and safe browsing practices. Employees are encouraged to report any security incidents promptly. Our communication channels ensure timely dissemination of information during incidents.

## **Part 11 System Configuration**

### **11.1 DEVICE NAMING CONVENTIONS**

- .1 Naming for devices and equipment comprising the security systems shall adhere to the following naming convention standards:

Level	Content	Range
1	Enterprise	Utilized to designate all enterprise level systems (ie. HWDSB)
2	Portfolio	This level allows for differentiation by major categories such as by geography (ie. EAST, WEST etc) or property type (ex. PRIM., SEC., EDC,) or other.
3	Site/Building	This field represents each standalone property or a complex having multiple buildings.
4	System	The type of system (ie. CCTV, etc.)
5	Floor	The floor of the building that the device or component resides. This may be coupled with other details like geographic orientation (ie. NW, SW, NE, SE) or room location (E101, M301)
6	Equipment	The individual component identifier (ex. C1-01, CS-01 see below for further details)

- .2 All levels are to be separated by “-” (example for enterprise systems: Level1-level2-level3-level4- level5-level6, for property systems: Level3-level4-level5-level6.)
- .3 For level 6, the below format for each system component shall be adhered to:

Device code (XXX) Description	Device code (XXX) Description
ACP	Access control point
ALM	Alarm
CAM	Camera
DGP	Data Gathering Panel (ACAM)
DUR	Duress station
ICD	Duress Intercom Station
KPD	Keypad
RDR	Card reader

## Part 12 Warranty

### 12.1 GENERAL REQUIREMENTS

- .1 The ACAM shall be provided with a warranty for material including servers, software and hardware such as ACAM panels, readers, request to exit, electronic locks and power supplies for minimum of one (1) year.
- .2 The Lenel S2 VMS headend, servers, cameras and software shall be provided with a warranty of minimum one (1) year.
- .3 The cabling system must be installed by a ND&I with CommScope and backed by a CommScope AMP Netconnect 25-year System Warranty. The CommScope System Warranty shall be facilitated by the contractor and be established between HWDSB and CommScope. No third-party certifications or third-party warranties are allowed.
- .4 Full one (1) year warranty including equipment, materials, and labour shall be provided after total completion of respective site. The warranty shall include the revision and implementation of all software and firmware upgrades released during the warranty period.
- .5 Timely response to service requests is a requirement. As a minimum during the warranty period, provide a guaranteed response time of six (6) hour for any system or component failure on a 24 hour per day, 7 days per week basis. Replacement hardware where required should be available “next business day”.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 CAN/ULC-S524 (latest edition), Installation of Fire Alarm Systems.
- .2 ULC-S525 (latest edition), Audible Signal Appliances for Fire Alarm Systems.
- .3 CAN/ULC-S526 (latest edition), Visual Signal Appliances, Fire Alarm.
- .4 CAN/ULC-S527 (latest edition), Control Units, Fire Alarm.
- .5 CAN/ULC-S528 (latest edition), Manual Pull Stations.
- .6 CAN/ULC-S529 (latest edition), Smoke Detectors.
- .7 CAN/ULC-S530 (latest edition), Heat Actuated Fire Detectors, Fire Alarm.
- .8 CAN/ULC-S531 (latest edition), Smoke Alarms.
- .9 CAN/ULC-S536 (latest edition), Inspection and Testing of Fire Alarm Systems.
- .10 CAN/ULC-S537 (latest edition), Verification of Fire Alarm Systems.
- .11 CAN/ULC-S552 (latest edition), Inspection, Testing and Maintenance of Smoke Alarms.
- .12 CAN/ULC-S553 (latest edition), Installation of Smoke Alarms.
- .13 OBC-2024, Ontario Building Code Compendium.

**1.2 DESCRIPTION OF SYSTEM**

- .1 System includes:
  - .1 Renovation work required on existing base building single stage fire alarm system, including required tie-ins of new fire alarm and sprinkler devices to the main control panel **Simplex 4100ES Series** to carry out fire alarm and protection functions for new addition.
  - .2 Addressable manual alarm stations.
  - .3 Addressable automatic alarm initiating devices.
  - .4 Audible and visual signal devices.
  - .5 End-of-line devices.
  - .6 Annunciators.
  - .7 Ancillary devices.
  - .8 Interface and zone modules.
  - .9 Remote trouble indicator.

**1.3 REQUIREMENTS OF REGULATORY AGENCIES**

- .1 This system is subject to review by local building department officials, local fire department officials. **Therefore, submission of verification certificate and field technician device verification sheets is required prior to inspection by these officials. Schedule accordingly.**

**1.4 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Electrical General Requirements Section.
- .2 Include:
  - .1 Layout of equipment.
  - .2 Zoning.
  - .3 Complete wiring diagram.

**1.5 OPERATION AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data for Fire Alarm System for incorporation into manual specified in Electrical General Requirements Section.
- .2 Include:
  - .1 Operation and maintenance instructions for complete fire alarm system to permit effective operation and maintenance.
  - .2 Technical data - illustrated parts lists with parts catalogue numbers.
  - .3 Copy of approved shop drawings.
  - .4 List of recommended spare parts for system.

**1.6 MAINTENANCE MATERIALS**

- .1 Include:
  - .1 10% spare glass rods for total number of manual pull box stations if applicable.

**1.7 TRAINING**

- .1 Arrange and pay for on-site demonstrations by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system. **Obtain written receipt of training session and include in maintenance manual.**

**1.8 SYSTEM OPERATION**

- .1 The system shall be configured for single stage operation as outlined on the design drawings. Refer to Fire Alarm Sequence of Operation for specific fire alarm sequence functions which generally include the following:
  - .1 Activation of audible and visual signal devices.
  - .2 Cause alarm and supervisory zone of alarm device to be indicated on control panel and remote annunciator(s).
  - .3 Cause system trouble indications.
  - .4 Activate auxiliary functions.
  - .5 Transmit signal to fire department via monitoring station.
  - .6 Log the alarm in the historical alarm log file.
  - .7 System silence parameters.
  - .8 System reset parameters.



**1.9 PERFORMANCE CRITERIA**

- .1 These specifications describe the minimum functional requirements for an electronically supervised, microprocessor based, fully integrated system. The initial installation shall include all the necessary electronic hardware, software and memory for a completely operable system in accordance with these specifications.

**1.10 QUALITY ASSURANCE**

- .1 Each and all items of the fire alarm system shall be listed as the products of a single manufacturer under the appropriate category by the Underwriter's Laboratories of Canada and shall bear the "U.L.C." label.
- .2 Each and all items of the fire alarm system shall be covered by a one year parts and labour warranty covering defects resulting from faulty workmanship and materials. The warranty shall be deemed to begin on the date the system is accepted by the Project Manager on issuance of the substantial performance certificate for the project.
- .3 All control equipment must have Transient Protection Devices to comply with U.L.C. requirements.

**Part 2 Products**

**2.1 GENERAL**

**2.2 ADDRESSABLE MANUAL ALARM STATIONS**

- .1 Manual alarm stations shall be addressable, single action, non-coded, semi-flush mounted type. Pull stations shall be break-glass style. Contacts are to activate when the handle is pulled down.
- .2 Addressable pull station electronics shall be mounted to the back plate of the station. The station's address will be set at the time of installation. Device addressing shall be accomplished by either an electrical or mechanical means.
- .3 Where noted on drawings, stations are to be equipped with tamperproof guard equal to Stopper II Cat. # STI-1100.

**2.3 INTELLIGENT DETECTORS-GENERAL OPERATION**

- .1 Addressable devices shall use simple to install and maintain decade, numbered 0 to 9, address switches. Detectors that have expanded addressing will have decade switch numbered from 0 to 15 for the most significant digit to allow detector addressing from 1 to 250.
- .2 Device addressing shall be accomplished by either an electrical or mechanical means.
- .3 Detectors shall be intelligent (analog) and addressable and shall connect with two wires to the fire alarm control panel signalling line circuits.

- 
- .4 Addressable smoke detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.
  - .5 The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. Sensitivity shall be automatically adjusted by the panel on a time-of-day basis.
  - .6 Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance.
  - .7 The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature.
  - .8 The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
  - .9 Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (PHOTO, THERMAL).
  - .10 Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.
  - .11 Detectors shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LEDs shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.
  - .12 Addressable devices shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LED(s) shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.
  - .13 The sensors shall be of a low profile design and ULC listed for both ceiling and wall mount applications.
  - .14 Automatic smoke sensors shall be equipped with a dust cover, which shall be removed at the time of verification to prevent dust and dirt entering the smoke chamber during construction.
  - .15 A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.

## **2.4 INTELLIGENT MULTI-DETECTOR**

- .1 The intelligent multi-detector shall be an addressable device, which is designed to monitor photoelectric, ionization, and thermal technologies in a single sensing device. This detector shall utilize advanced electronics which react to smaller products of combustion found in fast flaming fires (ionization), slow smouldering fires (photoelectric), and heat (thermal) all within a single sensing device.
- .2 The multi-detector shall include two bicolor LEDs, which flash green in normal operation and turn on steady red in alarm.
- .3 Detectors are to be provided with relay base where noted on the drawings.
- .4 Separately mounted photoelectric ionization and heat detectors in the same location are not acceptable alternatives.

## **2.5 FIXED TEMPERATURE HEAT DETECTOR**

- .1 These heat detectors shall have a low mass thermistor heat sensor and operate at a fixed temperature. It shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the/ time required to process an alarm. The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of the data. The heat detector shall have a nominal alarm point rating of 57°C (135°F). The heat detector shall be rated for ceiling installation at a minimum of 21.3 m (70') centres and be suitable for wall mount applications.

## **2.6 FIXED TEMPERATURE / RATE OF RISE HEAT DETECTOR**

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

## **2.7 PHOTOELECTRIC SMOKE DETECTOR**

- .1 The intelligent photoelectric detector shall utilize a light scattering type photoelectric smoke sensor to sense changes in air samples from its surroundings. The integral microprocessor shall dynamically examine values from the sensor and initiate an alarm based on the analysis of data. The detector shall continually monitor any changes in sensitivity due to the environmental affects of dirt, smoke, temperature, aging, and humidity. The photo detector shall be rated for ceiling installation at a minimum of Soft (Olin) centres and be suitable for wall mount applications.

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

## **2.8 STANDARD DETECTOR MOUNTING BASES**

- .1 Provide standard detector mounting bases suitable for mounting on North American 1-gang, 85 mm (3 ½ ") or 100 mm (4") octagon box and 100 mm (4") square box. The base shall, contain no electronics, support all detector types and have the following minimum requirements:
  - .1 Removal of the respective detector shall not affect communications with other detectors.
  - .2 Terminal connections shall be made on the room side of the base. Bases which must be removed to gain access to the terminals shall not be acceptable.

## **2.9 INTELLIGENT DUCT SMOKE DETECTOR**

- .1 The smoke detector housing shall accommodate an intelligent photoelectric detector (as noted above) that provides continuous analog monitoring and alarm verification from the panel.
- .2 When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.
- .3 Duct smoke detector sensor assemblies shall be complete with duct housing, photoelectric smoke detector, and sampling tubes as required. The duct-housing base shall come complete with an auxiliary set of form C dry contacts rated at 120 VAC, 3 Amps.
- .4 The system shall automatically indicate when an individual duct sensor needs cleaning.

## **2.10 CONVENTIONAL AUTOMATIC ALARM INITIATING DEVICES**

- .1 Smoke detector: photo electric type air duct type with sampling tubes with protective housing.
  - .1 Plug-in type with fixed base.
  - .2 Wire-in base assembly with integral red alarm LED, and terminals for remote alarm LED.

## **2.11 AUDIBLE/VISUAL SIGNAL DEVICES**

- .1 Horn: flush mounted temporal horn, 24Vdc operation, 94 dBA rating at 3 m (10'), red finish, FM and ULC listed.

- .2 Mini Horns: flush mounted temporal mini horn, 24Vdc operation, selectable HIGH/LOW setting 94.5 dBA (high)/89.8 dBA (low) at 3 m (10'), white or red coverplate, FM and ULC listed. Suitable for mounting on a single gang box.
- .3 Strobe: semi-recessed, 24Vdc operation, complete with selectable 15/30/75/110 candela output (unless otherwise noted set at 75 cd), synchronized strobe, red finish, FM and ULC listed. Suitable for mounting on a single gang box.
- .4 Mini Horn/Strobe: flush mounted temporal combination mini horn/strobe, 24 Vdc operation, selectable HIGH/LOW setting 94.5 dBA (high)/89.8 dBA (low) at 3 m (10') selectable 15/30/75/110 candela output (unless otherwise noted set at 75 cd), synchronized strobe white or red coverplate, FM and ULC listed. Suitable for mounting on a single gang box.

**NOTES:**

- .1 **Any surface mounted signal devices must be provided with suitable backboxes supplied by the manufacturer.**
- .2 **Provide synchronization modules to suit signal devices (if required by manufacturer).**
- .3 **Set signal devices in classrooms to LOW setting.**

**2.12 END OF LINE RESISTORS**

- .1 End-of-line resistors for signalling circuits shall be sized to ensure the correct supervisory current flows in each circuit.
- .2 End-of-line resistors shall be mounted on a stainless steel plate for mounting on a standard single gang box and bear the ULC label.

**2.13 GRAPHIC DISPLAY (PASSIVE)**

- .1 Black and white layout of facility showing all zones as specified/indicated.
- .2 Display is to be found behind Plexiglas, approximate size: 500 mm x 500 mm (20" x 20").
- .3 Finish frame to architects direction.

**2.14 ANCILLARY DEVICES**

- .1 Relay unit to initiate fan shutdown on air handling units equipped with duct detectors.
- .2 Additional contractors for BAS system to monitor fire alarm status as listed on fire alarm riser.
- .3 Relays to lighting control system to raise lighting to full and mute sound on listed systems per fire alarm riser diagram.
- .4 Relay unit to facilitate elevator recall functions as indicated.

## **2.15 INTELLIGENT MODULES – GENERAL OPERATION**

- .1 The modules shall have a minimum of 2 diagnostic LED's mounted behind a finished coverplate. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status. The module shall be capable of storing up to 24 diagnostic codes, which can be retrieved for troubleshooting assistance. Input and output circuit wiring shall be supervised for open and ground faults. The module shall be suitable for operation in the following environment:
  - .1 Temperature: 0°C to 49°C (32°F to 120°F).
  - .2 Humidity: 0-93% RH, non-condensing.

## **2.16 MONITOR MODULE**

- .1 The monitor modules shall have the following operating characteristics:

A flashing LED indicates that the module is in communication with the control panel. The LED latches steady on alarm (subject to current limitations on the loop).
- .2 The monitor modules shall have the following features:

Nominal operating voltage:	15 to 32 VDC.
Maximum current draw:	5.1 mA (LED on)
Average operating current:	400 uA (LED flashing)
EOL resistance:	47K ohms.
Temperature range:	0°C to 49°C (32°F to 120°F)
Humidity range:	10% to 93% noncondensing
Dimensions:	114.3 mm (4.5") high x 101.6 mm (4") wide x 31.75 mm (1.25") deep. Mounts to a 101.6 mm (4") square x 53.975 mm (2.1/8") deep box.

## **2.17 ISOLATOR MODULE**

- .1 Fault isolator modules shall be provide to automatically isolate wire-to-wire short circuits on an SLC loop. The fault isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop. If a wire-to wire short occurs, the fault isolator module shall automatically open-circuit (disconnect) the SLC loop. When the short circuit condition is corrected, the fault isolator module shall automatically reconnect the isolated section of the SLC loop. The fault isolator module shall not require any address-setting, and its' operations shall be totally automatic. It shall not be necessary to replace or reset a fault isolator module after its normal operation. The fault isolator module shall mount in a standard 10.16 cm (4") deep electrical box, in a surface-mounted backbox, or in the fire alarm control panel. It shall provide a single LED which shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

## **2.18 CONTROL MODULE**

- .1 Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay.

- .2 The control module NACs may be wired for Style Z or Style Y (Class A/B) with up to 1 Amp of inductive A/V signal, or 2 Amps of resistive A/V signal operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to ensure that 100% or all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
- .3 The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 Amps at 30 VDC.

## **2.19 DOOR HOLD OPEN DEVICES**

- .1 Units to be complete with the following features:
  - .1 Wall mounted style.
  - .2 Long life electromagnet.
  - .3 Low current operation.
  - .4 Completely silent operation.
  - .5 25 lbf (111N) minimum holding force.
  - .6 Adjustable swivel contact plate.
  - .7 Brushed zinc finish.
  - .8 Maintenance free operation.
  - .9 Water resistant design.
  - .10 ULC, CSA, and FM approved.

## **2.20 SPRINKLER AND SUPERVISED VALVE CONNECTIONS**

- .1 Sprinkler and standpipe system contacts shall be provided by the mechanical/sprinkler contractor but connected into the fire alarm system by this Division.

## **2.21 FIRE SMOKE DAMPERS**

- .1 Fire smoke dampers complete with integral smoke detectors shall be provided by the mechanical contractor but connected into the fire alarm system by this Division.
- .2 Provide 120V 15A circuit and fire alarm connections to all fire smoke dampers c/w integral smoke detector. Power to fire smoke dampers can be daisy chained together based on area from the nearest local panel.
- .3 Coordinate exact location and connection requirements with mechanical contractor prior to rough-in. Refer to mechanical drawings for further details and requirements.

## **2.22 SMOKE ALARMS 120V HARDWIRED**

- .1 Photoelectric sensor 3-in-1 smoke alarm unit complete with LED strobe and CO alarm.
- .2 Integral 177 candela strobe with ability to synchronize to other interconnected strobe alarms during an alarm event.
- .3 120V hardwired with 10-year sealed battery backup (sealed 3V lithium battery on smoke and CO alarm portion only).

- .4 Low profile construction.
- .5 Auxiliary relay for use with smart building systems as specified.

## 2.23 SYSTEM WIRING

- .1 The system wiring must be FSA rated in conformance with the Electrical Safety Code to suit the type of installation.
- .2 Wiring shall be minimum #18 AWG twisted shielded pair in conduit. "Securex 2" armoured cable will be permitted to be used for "drops" to devices on accessible ceilings.
- .3 As indicated on system riser diagram initiating device wiring shall be run in a loop with a home run from the last device to the control panel (Class 'A' configuration). Wiring from the "loop" module to conventional devices must be supervised, run in conduit, and conform to the standards of the Electrical Safety Code.
- .4 Signal wiring is to be cross connected in a class 'B' configuration.
- .5 Install isolator modules and end of line resistors in service rooms no higher than 2.4 M AFF. Provide location of these devices at the time of shop drawing submission.
- .6 **These are the basic wiring requirements for system operation. Prior to tender close manufacturer and contractor are to confirm all necessary wiring specifications and requirements.**
- .7 **Fire Alarm System and Equipment shall be manufactured by Simplex for this project for required integration to the existing base building fire alarm system. Other manufacturers will not be considered or accepted.**

## 2.24 APPROVED EQUIPMENT

<u>DEVICE</u>	<u>SIMPLEX (Basis of Design Manufacturer)</u>
<b><u>Intelligent Devices</u></b>	
Manual Alarm Stations 1-Stage	4099-9001
Addressable Multi-Sensor	
Addressable Base	4098-9792
Addressable Base c/w Relay	4098-9791 c/w 2098-9737
Heat Sensor	4098-9733
Smoke Detectors	4098-9714



Duct Type Smoke Detector (c/w Air Sampling Tubes)	4098-9755 and 4098-9714
Monitor Module	ZAM-Monitor 4090-9001
Control Module	ZAM-Control 4090-9002
Isolator Module	4090-9116
<b><u>Conventional and Auxiliary Devices</u></b>	
Smoke Alarms 3-in-1 (120V hardwired) complete with Strobe, 10 Year Sealed Battery and CO Alarm	KIDDE Cat. # P4010ACLEDSCOCA
Carbon Monoxide Alarm 120V with Battery Backup	Kidde 900-0128-001 (Pro Series CO)
Duct type Smoke Detector (c/w Air Sampling Tubes.)	4098-9685C
Horn	True Alert Series
Mini Horn	4901-9858
Door Holder	2088 Series
Mini Horn complete with strobe	4906-9127
Strobe	4906-9101
Remote Trouble Indicator	RT1-1C

---

**Part 3                      Execution**

**3.1                        INSTALLATION**

- .1 All fire alarm devices and equipment pertaining to the new addition scope of work shall be installed in accordance with CAN/ULC-S524 (latest edition) and approved manufacturers manuals and wiring diagrams. The contractor shall furnish all conduit, wiring, outlet boxes, junction boxes, cabinets and similar devices necessary for the complete installation. All wiring shall be of the type recommended by the Electrical Safety Code, approved by local authorities having jurisdiction for the purpose, and shall be installed in dedicated conduit throughout.
- .2 Locate and install manual alarm stations and connect to alarm circuit wiring.
- .3 Locate and install detectors and connect to alarm circuit wiring. **Do not mount detectors within 1 m (39") of air outlets.** Maintain at least 600 mm (24") radius clear space on ceiling, below and around detectors. Locate duct type detectors in straight portions of ducts.
- .4 Connect alarm circuits to main control panel.
- .5 Locate and install signal devices and connect to signalling circuits.
- .6 Connect signalling circuits to main control panel.
- .7 Install end-of-line devices at end of applicable alarm and signalling circuits.
- .8 Install remote annunciator panels and connect to annunciator circuit wiring.
- .9 Locate and install door releasing devices.  
**Note: Door holders must release by way of local smoke detector and signal from main control panel. Provide additional relays to suit.**
- .10 Locate and install remote relay units to control fan shut down.
- .11 Sprinkler system: wire alarm and supervisory switches and connect to control panel.
- .12 **Provide 120V power and fire alarm connections to all fire smoke dampers c/w integral smoke detector. Connect all fire / smoke damper integral detector outputs to monitor modules for alarm condition and for monitoring of AC power to smoke damper as trouble condition at fire alarm panel based on module address. Coordinate exact location and connection requirements with mechanical contractor prior to rough-in. All fire smoke dampers c/w integral smoke detectors shall be provided and installed by mechanical contractor.**

**3.2                        PROTECTION**

- .1 Contractor is to ensure all fire protection system detectors are protected from dust, dirt, humidity, and water at all times during construction. This applies to detectors installed, stored on site or stored in storage containers. Any detectors that are damaged or dirty shall be replaced at the contractor's expense.

### **3.3 FIELD QUALITY CONTROL**

- .1 The system shall be installed and fully tested under the supervision of trained manufacturer's representative. The system shall be demonstrated to perform all the functions as specified.

### **3.4 ACCEPTABLE INSTALLER**

- .1 The fire alarm / life safety system specified herein shall be installed by an Authorized Electrical Contractor who is CFAA certified.

### **3.5 EXAMINATION**

- .1 Prior to the commencement of any of the work detailed herein, an examination and analysis of the area(s) where the Fire Alarm / Life Safety System and all associated components are to be installed shall be made.
- .2 Any of these area(s) which are found to be outside the manufacturers' recommended environments for the particular specified products shall be noted on a Site Examination Report which shall be given to the Building Owners Representative, and the Consultant.
- .3 Any shorts, opens, or grounds found on existing wiring shall be corrected prior to the connection of these wires to any panel component or field device.

### **3.6 DEMONSTRATION**

- .1 Each of the intended operations of the installed Fire Alarm / Life Safety System shall be demonstrated to the Building Owners' Representative and the Consultant.

### **3.7 SYSTEM TEST**

- .1 Perform tests in accordance with General Electrical Requirements Section and CAN/ULC-S537- (latest edition) Standard for the Verification of Fire Alarm Systems.
- .2 Fire alarm system:
  - .1 Test each device and alarm circuit to ensure noted devices transmit alarm to control panel and actuate general alarm and ancillary devices.
  - .2 Check annunciator panels to ensure zones are shown correctly.
  - .3 Simulate grounds and breaks on alarm and signalling circuits to ensure proper operation of system.
  - .4 Class A circuits.
    - .1 Test each conductor on all circuits for capability of providing alarm signal on each side of single open-circuit fault condition imposed near middlemost point of circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.
    - .2 Test each conductor on all circuits for capability of providing alarm signals during ground-fault condition imposed near middlemost point of circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.

- .5 Class B circuits
    - .1 Test each conductor on all circuits for capability of providing alarm signal on line side of single open-circuit fault condition imposed at electrically most remote device on circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.
  - .3 The control panel shall continuously perform as automatic self-test routine on each sensor, which will functionally check the sensor electronics and ensure the accuracy of the valves being transmitted to the control panel.
  - .4 Automatic testing will occur at a rate of one sensor every four minutes.
  - .5 The sensor's average analogue value is the average of the last 2000 recorded analogue entries of its chamber.
  - .6 Any sensor that fails this test shall indicate a '**SELF-TEST ABNORMAL**' trouble condition with the sensor's address at the control panel.
  - .7 The system shall automatically indicate when an individual sensor needs cleaning. When the sensor's average value reaches a predetermined value, a '**DIRTY SENSOR**' trouble condition shall be audibly and visually indicated at the local control panel for that sensor. IF a '**DIRTY SENSOR**' indication is left unattended and its average value increases to a second predetermined value, an '**EXCESSIVELY DIRTY SENSOR**' trouble condition shall be indicated at the local control panel for that sensor. To prevent false alarms, these '**DIRTY**' conditions shall in no way decrease the amount of smoke obscuration necessary to generate an alarm condition.
  - .8 An operator having a proper access level, shall have the capability to manually access the following information from the control panel:
    - .1 Primary Status
    - .2 Device Type
    - .3 Present Average Value
    - .4 Present Sensitivity Selected\*
    - .5 Highest Peak Detection Values (HVP)\*
    - .6 Sensor Range (Normal, Dirty, Excessively Dirty)
- \* Values shall be in 'percent of smoke obscuration' format so that no interpretation is required by the operator.

### 3.8 AUDIBILITY TESTING

- .1 Audibility Testing:
  - .1 The contractor is to coordinate an audibility test prior to occupancy of the facility. The test is to be performed by the representatives of the fire alarm manufacturer in the presence of the consultant. The test report is to be in chart form indicating:
    - .1 Project
    - .2 Date of test
    - .3 Room name and number
    - .4 Ambient dB level

- .5 Alarm dB level
- .6 Name of testing technician
- .2 The test results are to be submitted to the consultant for review prior to issuing to owner's representatives and/or authorities having jurisdiction.

### **3.9 SMOKE ALARM TESTING**

- .1 Perform tests on smoke alarms in accordance with CAN/ULC-S552-(latest edition) Standard for Inspection, Testing and Maintenance of Smoke Alarms, and in accordance with manufacturer's instructions.
- .2 Smoke testing shall be completed for each smoke alarm device installed (not button testing).
- .3 Each smoke alarm shall be individually tested. Smoke alarm interconnections shall also be tested such that all connected smoke alarms will sound when any one of the smoke alarms is tested.
- .4 At the completion of the project and in the presence of the consultant, test all smoke alarms. On company letterhead, the contractor is to prepare a chart indicating:
  - .1 project
  - .2 date
  - .3 equipment type
  - .4 certification of test completion of each individual device
  - .5 certification of testing conducted with smoke producing device
  - .6 certification of correct operation
  - .7 confirmation for all smoke alarms functioning together (integration between multiple smoke alarms in common space).
  - .8 actual period of testing (time of day)

### **3.10 INTEGRATED LIFE SAFETY SYSTEM TESTING**

- .1 This electrical contractor shall participate in integrated testing of this life safety system in conformance with Electrical General Requirements. Include all associated costs in tender.

### **3.11 ADDITIONAL INSTALLED FIRE ALARM SYSTEM COMPONENTS**

- .1 The electrical contractor is to include in their bid the cost to add three additional signaling devices to be installed and verified in locations as directed by the consultant. Note: This installation and verification and subsequent audibility test will be occurring after the initial audibility testing is complete.
- .2 The electrical contractor is to include in their bid the cost to add three additional fire detection devices (heat or smoke detectors) to be installed and verified in locations as directed by the consultant.

- .3 The electrical contractor is to include in their bid the cost to add two additional fire alarm zones with associated zone modules and including four additional isolation modules to be installed and verified as directed by the consultant.
- .4 The electrical contractor is to include in their bid the cost to add five additional fire smoke damper connections and 120V loss of power trouble signal with associated module and including five additional isolation modules to be installed and verified as directed by the consultant.

**END OF SECTION**