

# SPECIFICATIONS

---

## BINDER 'B' MECHANICAL & ELECTICAL

### OUR LADY OF FATIMA CATHOLIC ELEMENTARY SCHOOL

69 OLIVE STREET, GRIMSBY, ON



NIAGARA CATHOLIC  
DISTRICT SCHOOL BOARD

427 RICE ROAD,  
WELLAND, ONTARIO L3C 7C1

### NIAGARA CATHOLIC DISTRICT SCHOOL BOARD

<p><b>SVEDAS ARCHITECTS INC.</b></p> <p>1084 BOTANICAL DRIVE BURLINGTON, ONTARIO L7T 1V2</p>	<hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>	<p>TENDER NUMBER</p> <p>PROJECT <b>116808</b></p>
--	---	---

**ISSUED FOR TENDER 2017 02 28**

## **Division 20 Common Requirements for Mechanical**

- 20 00 01 Mechanical Specification Index
- Common Contract Requirements for Mechanical**
- 20 02 21 Mechanical Supplemental Tender Form
- 20 02 31 Mechanical Identified Prices
- Common Work Results for Mechanical**
- 20 05 11 Mechanical General Requirements
- 20 05 21 Demolition and Renovation
- 20 05 34 Bases, Hangers and Supports
- 20 05 48 Seismic Restraint
- 20 05 49 Vibration Isolation Measures
- 20 05 53 Mechanical Identification
- Testing, Adjusting, and Balancing**
- 20 06 11 Testing, Adjusting, and Balancing
- Commissioning for Mechanical**
- 20 08 11 Mechanical Contractor Closeout Requirements

## **Division 21 Fire Suppression**

- Fire-Suppression Sprinkler Systems**
- 21 13 13 Wet Pipe Fire Suppression

## **Division 22 Plumbing**

- Plumbing Insulation**
- 22 07 19 Thermal Insulation for Piping
- Facility Water Distribution**
- 22 11 16 Domestic Water Piping - Copper
- 22 11 20 Backflow and Cross Connection Measures
- 22 11 31 Plumbing Specialties and Accessories
- Facility Sanitary Sewerage**
- 22 13 16 Drainage Waste and Vent Piping – Cast Iron and Copper
- 22 13 17 Drainage Waste and Vent Piping – Plastic
- Plumbing Auxiliary Equipment**
- 22 36 13 Plumbing Equipment
- Fire Extinguishers**
- 22 37 13 Portable Fire Extinguishers
- Plumbing Fixtures**
- 22 44 13 Plumbing Fixtures and Trim

## **Division 23 Heating, Ventilating, and Air**

- HVAC Insulation**
- 23 07 13 Thermal Insulation for Ducting
- 23 07 14 Acoustic Duct Lining
- Facility Fuel Piping**
- 23 11 23 Piping, Valves & Fittings – Gas

## **Hydronic Piping and Pumps**

- 23 21 11 Thermometers and Pressure Gauges – Piping System
- 23 21 12 Flexible Connections, Expansion Joints, Anchors & Guides
- 23 21 13 Hydronic Systems Steel
- 23 21 18 Hydronic Specialties
- 23 21 23 Pumps Hydronic

## **HVAC Water Treatment**

- 23 25 13 HVAC Water Treatment

## **HVAC Ducts and Casings**

- 23 31 13 Ductwork

## **Air Duct Accessories**

- 23 33 13 Duct Accessories
- 23 33 14 Dampers - Balancing
- 23 33 16 Dampers - Fire
- 23 33 18 Dampers - Operating
- 23 33 19 Sound Attenuation
- 23 33 46 Flexible Ducts

## **HVAC Fans**

- 23 34 11 Commercial Fans
- 23 34 23 Packaged Exhausters

## **Air Terminal Units**

- 23 36 16 Variable-Air Volume Units

## **Air Outlets and Inlets**

- 23 37 13 Grilles, Registers, and Diffusers
- 23 37 23 Louvres, Intakes and Vents

## **Ventilation Hoods**

- 23 38 13 Commercial-Kitchen Hoods

## **Breeching, Chimneys, and Stacks**

- 23 51 33 Breeching and Chimneys

## **Heating Boilers**

- 23 52 17 Stainless Steel Condensing Steel Boilers

## **Air-To-Air Energy Recovery Equipment**

- 23 72 13 Heat Wheel Air to Air Energy Recovery Ventilators

## **Outdoor Air-Handling Units**

- 23 73 23 Built-Up Air Handling Units

## **Convection Heating and Cooling Units**

- 23 82 29 Hydronic Heating
- 23 82 31 Hydronic Radiant Ceiling Panels

## **Division 25 Integrated Automation**

### **Common Work Results for Integrated Automation**

- 25 05 11 Variable Frequency Drives

### **Building Automation System**

- 25 20 11 Building Automation System

**END OF SECTION**

**1 General**

**2 1.1 INSTRUCTIONS TO BIDDERS**

.1 The Supplemental Tender Form shall be **SUBMITTED TO THE CONSULTANT WITHIN 2 HOURS OF TENDER CLOSING** by email (dei@deiassociates.ca). Mechanical Contractors shall identify all sub-contractors he intends to use and must complete all information requested or tenders may be considered null and void. Should any uncertainty arise as to the proper manner or submitting tenders, the requisite information will be given at the office of the Consultant. Contractor shall initial and date each page.

.2 CONTRACTOR

I \_\_\_\_\_ hereby submit this tender form with approved equivalent and alternate bid forms and agree to use the following subcontractors and equipment as marked herein.

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

SUB-CONTRACTORS

The Contractor shall state below the name of the Insulation, Fire Protection, Sheet Metal, Temperature Controls, and TAB sub-contractor he intends to use, which shall not be changed without the consent of the Consultant.

Insulation \_\_\_\_\_

Fire Protection \_\_\_\_\_

Sheet Metal \_\_\_\_\_

Temperature Controls \_\_\_\_\_

TAB \_\_\_\_\_

.3 The Stipulated Bid Sum shall be for the base bid manufacturer or supplier equipment only, unless otherwise indicated. Where a choice of this equipment is given, this Contractor shall indicate the supplier or manufacturer he intends to use. Where no choice is indicated, the base bid supplier or equipment shall be used.

.4 Equipment or materials manufactured by firms named in the following listing only shall be deemed equal to the equipment or material specified, provided the equipment or material will have capacity, performance, rating, construction, physical dimensions, accessories and features which, in the opinion of the Consultant, are equal to those of the specified equipment or material. The Mechanical Contractor shall not indicate equipment, materials or suppliers which are not listed.

Contractor's Initials: \_\_\_\_\_

Date: \_\_\_\_\_

- .5 Where modifications to the work of other trades are required as a result or part of the alternative offered; include the cost of said modifications in the work.
- .6 Submit the following list of Base Bid and alternative suppliers in accordance with the bid requirements:

Spec. Reference Section	Equipment	Base Bid	Acceptable Alternate Manufacturer Or Supplier	Indicate Manufacturer Or Supplier
20 05 49	Vibration Isolation	Vibron Ltd.	Vibro - Acoustics Korfund	_____
22 07 19 / 23 07 13	Thermal Insulation	Fibreglass Canada	Knauf Manson Johns Manville Pittsburgh Corning Roxul	_____
22 11 31	Strainers	Watts	Wilkins Crane/Powers Colton	_____
22 11 31	Drainage Products	Zurn Industries	Ancon Enpoco Mifab Watts Drainage Contou Smith	_____
22 11 31	Hydrants	Zurn Industries	Ancon Contour Mifab	_____
22 11 31	Backflow Preventers	Watts	Wilkins Conbraco	_____
22 11 31	Grease/ Interceptors	Zurn Industries	Ancon Mifab	_____
22 44 13	Plumbing Fixtures	American Standard	Koehler Crane	_____

Contractor's Initials: \_\_\_\_\_

Date: \_\_\_\_\_

Spec. Reference Section	Equipment	Base Bid	Acceptable Alternate Manufacturer Or Supplier	Indicate Manufacturer Or Supplier
22 44 13	Flush Valves	Sloan	Zurn Industries Delta	_____
22 44 13	Fixture Carriers	Zurn Industries	Ancon Smith	_____
22 44 13	Stainless Steel Sinks	Delta	Moen Zurn Industries	_____
22 44 13	Water Closet Seats	Bemis Centoco	Olsonite	_____
23 21 11	Thermometers Pressure gages	Treice	Weiss Winters	_____
23 21 13	Balancing Valves	Armstrong	Bell & Gossett	_____
23 21 23	Hydronic Pumps	Armstrong	Bell & Gossett	_____
23 34 23	Exhaust Fans	Greenheck	Penn Barry Cook Jenn Carnes Acme	_____
23 36 16	VAV Boxes	E.H. Price	Nailor Krueger Titus Carnes Metalaire	_____
23 37 13	Grilles and Diffusers	E. H. Price	Nailor Titus Kreuger Metalaire	_____
23 37 13	Portable Fire Extinguishers And Cabinets	Wilson & Cousins	National	_____

Contractor's Initials: \_\_\_\_\_

Date: \_\_\_\_\_

Spec. Reference Section	Equipment	Base Bid	Acceptable Alternate Manufacturer Or Supplier	Indicate Manufacturer Or Supplier
23 73 23	Built Up Air Handling Units	Engineered Air	Haakon Temprite Industries	_____
23 82 29	Hydronic Heating	Engineered Air	Slant/Fin Sigma Dunham Bush Sterling Rittling	_____

**1.2 LABOUR RATES**

.1 The following labour rates shall apply for calculating the cost of credit or extras on Change Notices. The rates shall include any employee benefits. The labour rates do not include overhead and profit.

- Superintendent \$\_\_\_\_\_/hr
- Journeymen \$\_\_\_\_\_/hr
- Labourers \$\_\_\_\_\_/hr
- Plumbers \$\_\_\_\_\_/hr
- Sheet Metal \$\_\_\_\_\_/hr
- Other \$\_\_\_\_\_/hr
- \$\_\_\_\_\_/hr

Contractor's Initials: \_\_\_\_\_

Date: \_\_\_\_\_

**1.3 MECHANICAL TENDER PRICE (EXCLUDING GST)**

- .1 Having carefully examined all Drawings and Specifications and the Addenda to the Drawings and Specifications, and having carefully examined the sites and all conditions affecting the work, we, the undersigned thereby offer to provide all plant, labour, materials and incidentals required to complete the work for the Total Stipulated Price of:

\$ \_\_\_\_\_

\_\_\_\_\_

(in writing)

in lawful money of Canada; included in which are all applicable excise taxes, custom duties, freight, exchange, and all other charges. H.S.T. is not included.

**END OF SECTION**

Contractor's Initials: \_\_\_\_\_

Date: \_\_\_\_\_

**PAGE INTENTIONALLY LEFT BLANK**

Contractor's Initials: \_\_\_\_\_

Date: \_\_\_\_\_

**1 General**

**1.1 GENERAL**

- .1 The following Mechanical Identified Prices Form must be submitted to the architect and consultant within 2 hours of tender closing. Mechanical contractors must complete all information requested or tenders may be considered null and void. Should any uncertainty arise as to the proper manner of submitting tenders, the requisite information will be given at the office of the Consultant. Contractor shall sign and date this page and initial and date each page thereafter.

**1.2 CONTRACTOR**

I/We certify that I/We have the authority to bind the company.

\_\_\_\_\_  
COMPANY NAME

\_\_\_\_\_  
AUTHORIZED SIGNATURE

\_\_\_\_\_  
ADDRESS

\_\_\_\_\_  
PRINTED SIGNATURE

\_\_\_\_\_  
CITY

\_\_\_\_\_  
TITLE

\_\_\_\_\_  
TELEPHONE NUMBER

\_\_\_\_\_  
DATE

\_\_\_\_\_  
FAX

**1.3 RELATED SECTIONS**

- .1 This section must be read in association with the following: Division 1, Mechanical and Electrical Divisions.

CONTRACTOR'S NAME: \_\_\_\_\_ DATE: \_\_\_\_\_

**1.4 UNIT PRICES (EXCLUDING HST)**

- .1 Unit prices are for complete work, in place, supplied, and installed in accordance with applicable contract requirements. Unit prices correspond to the unit of measure listed. Owner may use the unit prices for calculating additions or deletions to work.

Unit of Work	Unit of Measure	Addition	Deletion
1. Addition of sprinkler head	_____	\$ _____	\$ _____
2. Deletion of sprinkler head	_____	\$ _____	\$ _____

**END OF SECTION**

CONTRACTOR'S NAME: \_\_\_\_\_ DATE: \_\_\_\_\_

**1 General**

**1.1 GENERAL PROVISIONS**

- .1 This section covers items common to all sections of Mechanical Division.
- .2 Conform to Division 1 General Conditions.
- .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 mechanical 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 TENDERS**

- .1 Complete Supplemental Tender Forms including list of equipment and materials to be used on this project and forming part of tender documents.
- .2 Submit Supplemental Tender Form as noted.
- .3 Submit tender based on specified described equipment or Alternates listed.
- .4 State in Tender, names of all Subcontractors proposed for work under this Division.

#### 1.4 REGULATIONS, PERMITS AND FEES

- .1 All materials and quality of work shall meet all 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 Special Inspection Department of the HEPC 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.
- .5 Submit a copy of all final certificates in the maintenance manuals.

#### 1.5 DRAWINGS

- .1 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.
- .2 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.
- .3 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.
- .4 Install piping and ductwork to clear structural members and any fireproofing. Locate mechanical 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.

- .5 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.
- .6 Locate all mechanical and electrical equipment in such a manner as to facilitate easy and safe access to and maintenance and replacement of any part.
- .7 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.
- .8 Relocate equipment and/or material installed but not co-ordinated with work of other Sections and/or installed incorrectly as directed, without extra charge.
- .9 Where drawings are done in metric and product not available in metric, the corresponding imperial trade size shall be utilized.

#### **1.6 INTERFERENCE AND CO-ORDINATION 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 co-ordinated.
- .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, 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 release AutoCAD 2007) in addition to hard copies.

#### **1.7 QUALITY ASSURANCE**

- .1 Perform work in accordance with applicable provisions of local Plumbing Code, Gas Ordinances, and adoptions thereof for all mechanical 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.

## 1.8 ALTERNATES AND SUBSTITUTIONS

- .1 Throughout Mechanical Division are lists of "Alternate Equipment" manufacturers acceptable to Consultant if their product meets characteristics of specified described equipment.
- .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. Prices are not required in Tender for Alternates listed except where specifically noted in Section 15008. Complete the Supplementary Tender Form.
- .3 It is 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, state in Tender proposed substitute and amount added or deducted for its use. Extra monies will not be paid for substitutions after Contract has been awarded.
- .5 If pipe or item, of size or weight indicated, is unobtainable, supply next larger size or heavier weight without additional charge.

## 1.9 EXAMINATION

- .1 Site Inspection
  - .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 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.

### 1.10 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 mechanical 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 Mechanical 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 Mechanical 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 Mechanical 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.

#### 1.11 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 (max. \$5000.00)
  - Inside buried plumbing and drainage
  - Above grade rough-in plumbing and drainage
  - Roof drainage system
  - Plumbing Fixtures
  - Sprinkler system and heads
  - Boilers
  - Hydronic piping
  - Circulation pumps
  - Piping Insulation
  - Ductwork
  - VAV box installation
  - Duct Insulation
  - Grilles & Diffusers
  - Fire Stopping
  - Fans & Equipment
  - Building Automation Systems
  - Testing Adjusting and Balancing
  - Mechanical contractor closeout requirements minimum (\$10,000.00)

- .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.

## 1.12 COMMISSIONING CONTRACTOR (CC)

- .1 This contractor shall work with the HVAC system commissioning contractor as specified elsewhere. The Commissioning Contractor will be retained by the Owner.

## 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 30 days after award of Contract.
- .2 Provide a complete list of shop drawings to be submitted prior to first submission.
- .3 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.
- .4 Shop drawings can be submitted either by hard (paper) copy submission or by an electronic submission as per the following directions.
  - .1 State sizes, capacities, brand names, motor HP, accessories, materials, gauges, dimensions, and other pertinent information.
  - .2 List on catalog covers page numbers of submitted items.
  - .3 Underline applicable data.
  - .4 Hard copy:
    - .1 Submit 6 copies of data **in 6 individual binders** and index in same order and name as they appear in Specification. **Prior to submission these shop drawings must be reviewed by the contractor and bear the "company stamp" of the contractor. If not stamped the drawings will not be reviewed.**
  - .5 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 **3** copies of "reviewed" shop drawings and compile into maintenance manuals.
- .5 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.
- .6 Partial submittals will not be accepted.
- .7 If material or equipment is not as specified or submittal is not complete, it will be rejected by Consultant.
- .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 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.

#### 1.14 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 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 drainage, waste and vent piping to Ontario Building Code and authorities having jurisdiction.
  - .5 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 Test fire systems in accordance with authorities having jurisdiction 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.

## 1.15 RECORD DRAWINGS

- .1 Site records:
  - .1 Consultant will provide 2 sets of reproducible mechanical 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 mechanical systems, control systems and low voltage control wiring.
  - .2 On a weekly basis, transfer information to reproducible, 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 Record drawings:
  - .1 Prior to start of Testing, Adjusting and Balancing (TAB), finalize production of record drawings.
  - .2 Identify each drawing in lower right hand corner in letters at least 3 mm (1/8") high as follows: - "RECORD DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (date).
  - .3 TAB to be performed using record drawings.
  - .4 Submit hard copy to Consultant for approval. When returned, make corrections as directed.
  - .5 Once approved, submit completed reproducible paper record drawings as well as a scanned pdf file copy on USB stick with Operating and Maintenance Manuals.
- .3 Submit copies of record drawings for inclusion in Maintenance Manuals.
- .4 The contractor will include in his tender \$50.00 per drawing for DEI & Associates Inc. to CAD the red-line Record drawings. The CAD drawings files will be provided to the owner as part of the maintenance manuals.

## 1.16 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, consultant, contractor, building automation systems (BAS) contractor, and manufacturer's representative. Each person shall witness and sign off each piece of equipment.
- .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.

### 1.17 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 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.
- .4 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.
- .5 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.
- .6 Miscellaneous data to include:
  - .1 Letter of contractors 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.

- .7 Approvals:
  - .1 Submit 1 copy of draft Operation and Maintenance Manual to Consultant for approval. Submission of individual data will not be accepted unless so directed by Consultant.
  - .2 Make changes as required and re-submit as directed by Consultant.
  - .3 Provide three (3) 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 Record drawings.
  
- .8 Additional data:
  - .1 Prepare and insert into operation and maintenance manual when need for same becomes apparent during demonstrations and instructions specified above.

### **1.18 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 Mechanical 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 Mechanical Division, qualified manufacturers' representatives who are knowledgeable about the project to provide demonstrations and instructions.
- .4 Use operation and maintenance manual, record 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.

### **1.19 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 mechanical 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 mechanical 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 substantial completion.

## 1.20 SUBSTANTIAL PERFORMANCE

- .1 Complete the following to the satisfaction of the consultant prior to request for submission of substantial performance.
  - .1 Record Drawings.
  - .2 Maintenance Manuals
  - .3 System Start up
  - .4 TAB Reports
  - .5 HVAC System Commissioning
  - .6 Instructions to Owners
  - .7 Final Certificates (required prior to consultant's release of conformance letter).
    - NFPA-13 Contractors Material and Test Certificate
    - Sprinkler Design Engineers' Conformance Letter
    - Potable Water Test (Refer to Domestic Water Piping - Copper Section - Part 3)
    - TSSA Gas Pressure Test
    - Backflow Test Certificate(s)
    - Mechanical Seismic Restraint Engineers' Letter

## 1.21 OCCUPANCY REQUIREMENTS

- .1 The contractor shall provide the following documentation to the consultant prior to receiving occupancy. Failure to provide the proper documentation will result in the occupancy not being granted. List of required documentation:  
Final Certificates (required prior to consultant's release of conformance letter).
  - NFPA-13 Contractors Material and Test Certificate
  - Sprinkler Design Engineers' Conformance Letter
  - Potable Water Test (Refer to Domestic Water Piping - Copper Section - Part 3)
  - TSSA Gas Pressure Test
  - Backflow Test Certificate(s)
  - Mechanical Seismic Restraint Engineers' Letter

## 1.22 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 Domestic water
  - .4 Plumbing, and drainage.

### 1.23 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/suppliers invoice if requested.

### 1.24 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.

### 1.25 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.

## 1.26 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 mechanical 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
  - .6 Urinals (Adult) ± 600 (24)
  - .7 Hose bibbs +/- 600 (24")
  - .8 Barrier-free drinking fountains 840 mm (33") to rim  
Not less than 686 (27") under unit
  - .9 Fire extinguisher 1350 (4'- 0") to hanger
  - .10 Fire extinguisher cabinets 1500 (5'- 0") to top of cabinet
  - .11 Hydronic heating elements 200 mm (8") to bottom of cabinet
  - .12 Backflow preventors 900 – 1200 (3'- 4') to centerline of unit
  - .13 Thermostats: Barrier Free maximum 1100 mm (3' - 11")  
Non Barrier Free 1500 mm (5' - 0")

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

## 1.27 ANCHOR BOLTS AND TEMPLATES

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

## 1.28 PROTECTION OF OPENINGS

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

## 1.29 ELECTRICAL

- .1 Electrical work to conform to Electrical Division including the following:
  - .1 Supplier and installer responsibility and related mechanical responsibility is indicated in Equipment Schedule on mechanical and/or electrical drawings
  - .2 Control 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 Mechanical Division. Refer to 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.

### 1.30 MOTORS

- .1 Provide high efficiency motors for mechanical 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.

### 1.31 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.

### 1.32 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 in Floor
  - .1 Provide reinforced guard 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.

### **1.33 PIPING AND EQUIPMENT SUPPORTS**

- .1 Equipment supports supplied by equipment manufacturer: specified elsewhere in Mechanical 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.

### **1.34 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:  
Portable pipe hanger  
Bigfoot systems

### 1.35 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.

### 1.36 PIPE PENETRATION SEALS

- .1 Provide stainless steel waterproof wall flange complete with EPDM pipe seal with stainless steel hardware at all piping penetrations in foundation wall.
- .2 Pipe seals shall be suitable for 140 kPa (20 psi).
- .3 Acceptable Material:  
Link Seal

**1.37 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 cementious or rigid seals around penetrations for pipe, ductwork, or other mechanical items.
- .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, manufacturer's 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 Manufacturer:  
Minnesota Mining and Manufacturing

- .16 Acceptable Alternate Manufacturers to approval of local authority:  
Fryesleeve Industries Inc.  
General Electric Pensil Firestop Systems  
International Protective Coatings Corp.  
Rectorseal Corporation (Metacaulk)  
Proset Systems  
3M  
AD Systems  
Hilti
- .17 Ensure firestop manufacturer representative performs on site inspections and certifies installation. Submit inspection reports/certification at time of substantial completion.

### **1.38 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.

### **1.39 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.

### **1.40 SPARE PARTS**

- .1 Furnish spare parts in accordance with general requirements and as follows:
  - .1 One set of packing 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.

#### **1.41 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.

#### **1.42 ACCESS DOORS**

- .1 Provide access doors to concealed mechanical 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 Installation:
  - .1 Locate so that concealed items are accessible.
  - .2 Locate so that hand or body entry (as applicable) is achieved.
- .5 Acceptable materials:  
Le Hage  
Zurn  
Acudor  
Nailor Industries Inc.

#### **1.43 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.

**1.44 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.

**1.45 DELIVERY STORAGE & HANDLING**

- .1 Follow Manufacturer's directions in delivery, storage, and protection, of equipment and materials.
- .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.

**1.46 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.

**1.47 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.

**1.48 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.

**1.49 ASBESTOS**

- .1 If asbestos is suspected or identified cease all work in the immediate area in accordance with OSHA 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 asbestos due to the nature of the work that they perform, have received training that enables them to recognize asbestos and that enables them to react in accordance with the Occupational Health and Safety Act and regulations thereto should contact with asbestos occur during the course of their work.
- .4 **It is the responsibility of the contractor to review the asbestos book in the building prior to starting any work.**
- .5 Existing occupied buildings (depending upon their age) may contain asbestos 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 asbestos and shall not be disturbed.
- .6 **A survey of each building documenting the location and condition of asbestos-containing materials is available for your mandatory review prior to commencing any work on premises.**

**1.50 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.

### **1.51 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 mechanical systems which are not being reused are to be patched with the same material surrounding surfaces.
- .5 All new holes and openings to facilitate mechanical 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.

### **1.52 OWNER SUPPLIED EQUIPMENT**

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

### **1.53 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 DVD.
- .2 This contractor shall flush the new and existing storm and sanitary system to remove all debris prior to final videotaping of systems.

- .3 Provide 3 copies of DVD.
- .4 Identify video routing on Record drawings.

**1.54 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.

**1.55 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.

**1.56 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 Mechanical Contractor as specified under Division 2. Where backfilling outside the building is not specified under Division 2 the mechanical 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 mechanical 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.

#### **1.57 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 mechanical 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.

#### **1.58 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 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.

#### **1.59 ENERGY EFFICIENCY**

- .1 The mechanical 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**

**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.

**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.

**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 mechanical systems which are not being reused are to be patched with the same material surrounding surfaces.
- .5 All new holes and openings to facilitate mechanical 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 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.

**END OF SECTION**

PAGE INTENTIONALLY LEFT BLANK

**1 General**

**1.1 REFERENCES**

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
  - .1 ANSI/ASME B31.1-[1989], Power Piping, (SI Edition).
  - .2 American Society for Testing and Materials (ASTM)
    - .1 ASTM A 125-[81(1988)], Specification for Steel Springs, Helical, Heat-Treated.
    - .2 ASTM A 307-[94], Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
    - .3 ASTM A 563-[94], Specification for Carbon and Alloy Steel Nuts.
  - .3 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
    - .1 MSS SP-58-[1988], Pipe Hangers and Supports - Materials, Design and Manufacture.
    - .2 MSS SP-69-[1983], Pipe Hangers and Supports - Erection and Application.

**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, and 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.

## 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 HPS 2 maximum: Ductile iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
    - .1 Rod: 9 mm (1.3") 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 minimum greater than rod diameter.
    - .2 Concrete inserts: wedge shaped body with knockout protector plate ULC listed.
  - .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 (18 gauge) saddles.
- .8 Adjustable clevis: material to MSS SP-69 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-69 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-69.

### **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 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-69.

## **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 EQUIPMENT ANCHOR BOLTS AND TEMPLATES**

- .1 Provide templates to ensure accurate location of anchor bolts.

## **2.7 OTHER EQUIPMENT SUPPORTS**

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

## **2.8 ROOF MOUNTED EQUIPMENT**

- .1 Install as per manufacturers' instructions on roof curbs provided by manufacturer as indicated. Provide all necessary continuous wolmanized wood blocking as required to install roof curb level prior to setting of unit.

## **2.9 MANUFACTURER**

- .1 Acceptable Materials:  
Grinnell  
Myatt  
Thaler (where indicated).

## **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.

### 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 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 Within 300 mm (12") of each elbow and:

Pipe Size: NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1 1/4"	2.1 m (7')	1.8 m
1 1/2"	2.7 m (9')	2.4 m
2"	3.0 m (10')	2.7 m (9')
2 1/2"	3.6 m (12')	3.0 m (10')
3"	3.6 m (12')	3.0 m (10')
3 1/2"	3.9 m (13')	3.3 m (11')
4"	4.2 m (14')	3.6 m (12')
5"	4.8 m (16')	
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 from vertical.
- .2 Where horizontal pipe movement is less than 13 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**

**1 General**

**1.1 SECTION INCLUDES**

- .1 Seismic Requirements for single rod hanger supports 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 mechanical equipment and piping.

**1.2 RELATED WORK SPECIFIED ELSEWHERE**

- .1 Vibration Isolation Measures.

**1.3 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. & 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.

#### 1.4 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.

#### 1.5 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.

## 1.6 DESCRIPTON 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 mechanical services, and for the vibration isolation of same equipment. Nothing on the project drawings or specifications shall be interpreted as justification to waive the requirements of this seismic restraint section.
- .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.

## 1.7 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 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.

## 1.8 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.

## **1.9 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.

## **1.10 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 mechanical 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 mechanical equipment, piping, or ductwork.

#### 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.

## 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 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 ( $h_r$ ) 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.

## **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 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 contractors 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**

**PAGE INTENTIONALLY LEFT BLANK**

**1 General**

**1.1 REFERENCES**

**1.2 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.

**2 Products**

**2.1 GENERAL**

- .1 Size and shape of bases type and performance of vibration isolation to be as indicated.

**2.2 ELASTOMERIC PADS**

- .1 Neoprene waffle or ribbed; 9 mm (1/3") minimum thick; 50 durometer; maximum loading 350 kPa.
- .2 Acceptable materials:  
Korfund  
Vibro-Acoustics  
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 SPRING MOUNT

- .1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.
- .2 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.
- .3 Performance: as indicated.
- .4 Acceptable materials:  
Korfund  
Vibron  
Vibro-Acoustics

## 2.5 HANGERS

- .1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30arc without metal to metal contact.
- .2 Stable spring, elastomeric washer, cup with molded isolation bushing which passes through hanger box.
- .3 Performance as indicated.
- .4 Acceptable materials:  
Vibron  
Korfund  
Vibro-Acoustics

## 2.6 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:  
Vibron  
Vibro-Acoustics

## 3 Execution

### 3.1 INSTALLATION

- .1 Install vibration isolation equipment in accordance with manufacturer's 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 4: first 3 points of support. NPS 5 to NPS 8: first 4 points of support. NPS 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 Section 15950 - Testing Adjusting and Balancing.
- .2 Vibration measurements shall be taken for equipment-listed in vibration isolation schedule and as indicated.
- .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**

**PAGE INTENTIONALLY LEFT BLANK**

**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.

**2 Products**

**2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES**

- .1 Metal or plastic lamicoïd 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 NAMEPLATES

- .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 damper is installed above gypsum ceiling install on adjacent wall.

## 2.4 PIPING SYSTEMS GOVERNED BY CODE

- .1 Identification:
  - .1 Natural gas: To CSA B149.1-00 and authority having jurisdiction and as indicated elsewhere.
  - .2 Sprinklers: To NFPA 13.

## 2.5 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 Background colour marking and legends for piping systems:

CONTENTS	BACKGROUND COLOUR MARKING	LEGEND
Hot water heating supply	Orange	HEATING SUPPLY
Hot water heating return	Orange	HEATING RETURN
Make-up water	Orange	MAKE-UP WTR
Domestic hot water supply	Green/Blue	DOM. HW SUPPLY (-°C)
Dom. HW recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Domestic tempered supply	Green/Blue	DOM. TEMPERED (-°C)
Trap primer	Green	TRAP PRIMER
Storm water	Green	STORM
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Condensate	Green	CONDENSATE
Natural gas	Yellow	NATURAL GAS
Gas regulator vents		to Codes
Sprinklers	Red	SPRINKLERS
Conduit for low voltage Control wiring	White	CONTROL WIRING___VOLTS

## 2.6 IDENTIFICATION DUCTWORK SYSTEMS

- .1 50 mm (2") high stenciled 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.

## 2.7 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.

## **2.8 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 contractor.

## **2.9 LANGUAGE**

- .1 Identification to be in English.

## **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.

**END OF SECTION**

**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.

**1.2 QUALIFICATIONS OF TAB PERSONNEL**

- .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 TAB contractors may quote:
- .1 Air Velocities Control Ltd.  
100 Premium Way  
Mississauga, Ontario L5B 1A2  
(905) 279-4433
  - .2 Designtest & Balance Inc.  
70 East Beaver Creek  
Richmond Hill, Ontario L4B 3B2  
(905) 886-6513
  - .3 Flowset Balancing Ltd.  
431 Willis Dr.  
Oakville, Ontario L6L 4V6  
(416) 410-9793
  - .4 VPG Associates  
2062 King Road  
King City, Ontario L7B 1K9  
(905) 833-4334

**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 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 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
- .2 TAB report to show all results in SI or imperial units as indicated on plans and to include:
  - .1 Project record drawings.
  - .2 System schematics.
- .3 Submit 6 copies of TAB Report to consultant for verification and approval, in English in D-ring binders, complete with index tabs.

### 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 SMACNA ASHRAE.
- .2 Do TAB of all systems, equipment, components, controls specified Mechanical Division including but not limited to following:
  - .1 Air handling systems and equipment
  - .2 Duct testing to SMACNA standards (Refer to 23 31 13).
- .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, glycol heating and chilled water cooling systems.
- .2 Standard: TAB to be the most stringent of TAB standards of SMACNA, ASHRAE.
- .3 Do TAB of all systems, equipment, components, controls specified 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 boiler, coil, 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 loop (main, main branch, branch, sub-branch of all hydronic systems, inlet connection of make-up water.

#### 1.21 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.

#### 1.22 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:

Positive	Negative
Corridors	Washrooms
- .4 Smoke test all exhaust hoods to requirements of, SMACNA ASHRAE.
- .5 Indicate settings on VFD's for maximum air handling unit air flows.

**END OF SECTION**

**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.

**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.

**3 Execution**

**3.1 THE CONTRACT CLOSE OUT PROCESS**

- .1 The mechanical contractor close out process shall consist of:
  - Shop Drawings and Record 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
  - Commissioning Consultant performance testing
  - Commissioning meetings
  - Operating and maintenance manuals
  - Training
  - Systems Demonstration and turnover
  - Testing forms
  - Warranties

### **3.2 SHOP DRAWINGS AND RECORD DRAWINGS**

- .1 Conform to General Requirements Section for shop drawings and record 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 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.

### **3.5 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.

### **3.6 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.

**3.7 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.

**3.8 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.

**3.9 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.

### 3.10 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 Architect.
- .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

### 3.11 OPERATION AND MAINTENANCE MANUAL

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

### 3.12 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 requiredSubmit 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>
Boilers, and Pumps	1½ hours
Air Handling Units	2 hours
Life Safety & Fire Protection Systems	½ hour
Water Treatment Systems	½ hour
The Mechanical System	2 hours

- .7 The minimum training for the BAS shall be as specified in 15921. 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.

### **3.13 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
  - 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 closeout process shall be allocated a value equal to fifteen thousand dollars (\$10,000.00).
- .2 The Mechanical Contractor shall submit all test and verification forms. The Consultant may 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**

**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.

**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.

.7 Relocate existing as required for new connections, fittings, valves, and equipment.

.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.

## 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 role grooved fittings.
  - .3 65 mm (2½") and larger: Schedule 10 steel pipe with role 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, etc.).
  - .3 White semi-recessed fusible link type brass pendent with adjustable, recessed escutcheon ring and cup. Sprinkler and escutcheon cup. Semi-recessed heads installed in supervised areas (classrooms, offices, seminar rooms etc.).
  - .4 Sidewall bronze: where indicated.
  - .5 Sprinkler heads with O-ring design shall not be used.
  - .6 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 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.

## **2.4 PRESSURE GAUGES**

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

## **2.5 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.

## **2.6 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.

## **2.7 DOUBLE CHECK VALVE ASSEMBLY (DCVA)**

- .1 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.
- .2 The checks shall be accessible for maintenance without removing the device from the line.
- .3 Complete with supervisory switches for connection and monitoring by the fire alarm.
- .4 Install to manufacturer's requirements and not higher than 1200 mm (4'-0") AFF.
- .5 Acceptable materials:  
Watts 709 2½" - 10"  
Wilkins 950 2" - 10", 350 4" - 6"  
Conbraco 40-100 Series

## 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.

### 3 Execution

#### 3.1 INSTALLATION

- .1 Install, inspect and test to acceptance in accordance with NFPA 13 and FC 403.
- .2 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.
- .3 Testing to be witnessed by authority having jurisdiction.
- .4 Space hangers and support of sprinkler piping in accordance with N.F.P.A. regulations.
- .5 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.
- .6 Provide hydraulic pump, temporary connections and labour required for tests.
- .7 Protect exposed work, in accordance with 'Painting' section.
- .8 Do not cover or conceal piping accessories or work prior to inspection and approval by authorities having jurisdiction.
- .9 Adjust equipment to satisfaction of authority having jurisdiction and consultant.
- .10 Protect equipment during painting. Replace damaged and painted components.
- .11 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.
- .12 Guarantee that the systems and equipment be installed in accordance with all Local and Provincial by-laws and the Building Code of Ontario.
- .13 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 This contractor shall provide a flow test to approval of local fire department and local water commission at nearest fire hydrant adjacent to building to determine actual water flow rate and pressure. Provide written test results with shop drawing submission.
- .2 Provide a forward flow test thru the bypass for each system to prove system demand can be provided thru the backflow preventor.

**END OF SECTION**

**1 General**

**1.1 RELATED SECTIONS**

- .1 Submittals.
- .2 Shop Drawings and Product Data.
- .3 Pipe hangers and Supports.

**1.2 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 C 335, Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
  - .2 ASTM C 921, Practice for Determining the Properties Jacketing Materials for Thermal Insulation.
  - .3 ASTM B 209M, Specification for Aluminum and Aluminum Alloy Sheet and Plate.
- .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): National Insulation Standards.

**1.3 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.

## 1.4 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.

## 1.5 QUALIFICATIONS

- .1 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.

## 1.6 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.

## 1.7 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.

## 2 Products

### 2.1 FIRE AND SMOKE RATING

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

### 2.2 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 C 335.

- .3 Type A-1: Rigid moulded mineral fibre 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.
  
- .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:
    - Fibreglass Canada
    - Knauf
    - Manson
    - Pittsburg Corning

### **2.3 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 (26 gauge) thick.

### **2.4 CEMENT**

- .1 Thermal insulating and finishing cement:
  - .1 To ASTM C553.
  - .2 Hydraulic setting or Air drying on mineral wool, to ASTM C 449M.

### **2.5 VAPOUR RETARDER LAP ADHESIVE**

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

### **2.6 INDOOR VAPOUR RETARDER FINISH**

- .1 Vinyl emulsion type acrylic, compatible with insulation.

## 2.7 OUTDOOR VAPOUR RETARDER FINISH

- .1 Vinyl emulsion type acrylic, compatible with insulation.
- .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m<sup>2</sup> (0.062 lb/ft<sup>2</sup>).

## 2.8 JACKETS

- .1 Polyvinyl Chloride (PVC):
  - .1 One-piece moulded type (and sheet) to CAN/CGSB-51.53 with pre-formed shapes as required.
  - .2 Colours: white.
  - .3 Minimum service temperatures: -20°C (-4°F).
  - .4 Maximum service temperature: 65°C (150°F).
  - .5 Moisture vapour transmission: 0.02 perm.
  - .6 Fastenings:
    - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
    - .2 Tacks.
    - .3 Pressure sensitive vinyl tape of matching colour.
- .2 Canvas:
  - .1 220 g/m<sup>2</sup> (0.0451 lb/ft<sup>2</sup>) cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.
  - .2 Lagging adhesive: Compatible with insulation.

## 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, and free from foreign material.

### 3.2 INSTALLATION

- .1 Install in accordance with TIAC National 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.

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

- .1 Application: At expansion joints, valves, primary flow measuring elements, flanges, and unions at equipment.
- .2 Design: To permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.
- .3 Insulation:
  - .1 Insulation, fastenings and finishes: same as system.
  - .2 Jacket: As per adjacent insulation.

### 3.4 PIPING INSULATION SCHEDULES

- .1 Insulation types and thickness' to conform to following tables.
- .2 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .3 Install insulator and jackets to applicable TIAC codes.
- .4 Insulate ends of capped piping with type and thickness indicated for capped service.
- .5 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
Hot Water Heating	A-1	40 (1½")	50 (2")	50 (2")	50 (2")	50 (2")
Domestic Water Piping	A-1	25 (1")	25 (1")	40 (1½")	40 (1½")	40 (1½")
Storm Piping (Horizontal & Vertical)	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")
Trap primer Piping	A-1	15 (½")	15 (½")	15 (½")	-	-

.6 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

.7 Connection: To appropriate TIAC code.

**END OF SECTION**

**1 General**

**1.1 REFERENCES**

- .1 ANSI/ASME B16.15-[1985], Cast Bronze Threaded Fittings, Classes 125 and 250.
- .2 ANSI B16.18-[1984], Cast Copper Alloy Solder Joint Pressure Fittings.
- .3 ANSI/ASME B16.22-[1989], Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- .4 ANSI B16.24-[1979], Bronze Pipe Flanges and Fittings, Class 150 and 300.
- .5 ASTM B88M-[89], Specification for Seamless Copper Water Tube (Metric).
- .6 MSS-SP-70-[1984], Cast Iron Gate Valves, Flanged and Threaded Ends.
- .7 MSS-SP-71-[1984], Cast Iron Swing Check Valves, Flanged and Threaded Ends.
- .8 MSS-SP-80-[1987], Bronze Gate, Globe, Angle and Check 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.

**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 Buried or embedded: copper tube, soft annealed, type K: to ASTM B88M, in long lengths and with no buried joints.

**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.

### 2.3 JOINTS

- .1 Solder: 95/5.
- .2 Teflon tape: for threaded joints.
- .3 Dielectric connections between dissimilar metals: dielectric fitting to ASTM F492, complete with thermoplastic liner.

### 2.4 BALL VALVES

- .1 All valves shall be of commercial grade and of same manufacturer.
- .2 NPS 100 mm (4") 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.
- .3 Acceptable materials:
  - Milwaulkee
  - Crane
  - Neuman Hattersley

### 2.5 BALANCING VALVES

- .1 Size 15 mm (1/2") to 50mm (2"): Bronze body, brass ball, NPT connections and variable orifice.
- .2 Differential pressure readout ports with internal EPT inserts and check valves, 6 mm (1/4")NPT tapped drain/purge ports, memory stop and calibrated nameplate.
- .3 Acceptable materials:
  - Bell & Gossett Circuit Setters
  - Armstrong
  - Taco
  - Tour & Anderson

### 2.6 SWING CHECK VALVES

- .1 NPS 50 mm (2") and under, soldered:
  - To MSS SP-80, Class 125, 860 kPa, 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, 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, cast iron body, flat flange faces, renewable seat, bronze disc, bolted cap.

### **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 manufacturer's instructions unless otherwise indicated.
- .7 Buried tubing:
  - .1 Lay in well compacted washed sand in accordance with AWWA Class B bedding.
  - .2 Bend tubing without crimping or constriction. Minimize use of fittings.

#### **3.2 VALVES**

- .1 Isolate equipment, fixtures and branches with ball valves.
- .2 Balance recirculation system using balancing 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 1 1/2 times maximum system operating pressure or 860 kPa.

### 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**

**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.

**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

**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.

**END OF SECTION**

**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 ANSI/AWWA C700, Cold Water Meters-Displacement Type, Bronze Main Case.
- .8 PDI-G101, Testing and Rating Procedure for 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.

## 2 Products

### 2.1 FLOOR DRAINS

- .1 Floor drains and trench drains: to CAN/CSA-B79.
- .2 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.  
Acceptable materials:  
Zurn ZN-415-B  
Mifab F100C  
Watts Drainage FD-100-C-AS-1 or FD-100-C-LS-1  
Enpoco  
Contour C2000R5NB or C2000S5NB
- .3 Type FD-2: combination funnel floor drain; cast iron body with integral seepage pan, clamping collar, nickel-bronze adjustable head strainer with integral funnel.  
Acceptable materials:  
Zurn ZN-415-F, ZN-415-BE, ZN-415-BF  
Mifab F1100C-EG  
Watts Drainage FD-100-C-EG-1  
Contour C2000R5HNB
- .4 Type FD-3: general duty; cast iron body, adjustable head, nickel bronze strainer, integral seepage pan, and membrane clamping collar suitable for flooring in kitchen/servery area.  
Acceptable materials:  
Zurn ZN-415-B  
Mifab F1100C  
Watts Drainage FD-100-C-AS-1 or FD-100-C-LS-1  
Enpoco.

### 2.2 ROOF DRAINS

- .1 Type RD-1: standard flow; cast iron body, under deck clamp and sump receiver to suit roof construction, flashing clamp ring with integral gravel stop, bearing pan, aluminum dome.  
Acceptable material:  
Zurn ZA121RC  
Mifab  
Ancon  
Smith  
Contour

## 2.3 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, beveled edge frame complete with anchoring lugs.  
Acceptable material:  
Zurn ZSS-1469  
Mifab C1400-RD  
Ancon CO-480-RD-3  
Contour C3700RAC
- .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.  
  
Cover for unfinished concrete floors: nickel bronze round, gasket, and vandal-proof screws.  
Acceptable material:  
Zurn ZN-1400 – HD or Zurn ZZN-1612  
Mifab C1100-XR-6  
Ancon CO-200-RX-1-6  
Contour C3000RXNB  
  
Cover for terrazzo finish: round polished nickel bronze with recessed cover for filling with terrazzo, vandal-proof locking screws.  
Acceptable materials:  
Zurn ZN-1400-Z  
Mifab C1100-UR-6  
Ancon CO-200-U-1-6  
Contour C3000RZNB  
  
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.  
Acceptable materials:  
Zurn ZN-1400-T – HD  
Mifab C1100-TS-6  
Ancon CO-200-TS-1-6  
Contour C3000SYNB  
  
Cover for ceramic tile floors: ½" thick heavy duty nickel bronze square, cover complete with gasket, vandal-proof screws, for flush finish.  
Acceptable material:  
Zurn ZN-1400 – T-HD or Zurn ZZN-1612  
Mifab C1100-S-6  
Ancon CO-200-S-1-6  
Contour C3000SNB

## 2.4 NON FREEZE WALL HYDRANTS (RECESSED, ENCASED) (HB-1)

- .1 Recessed, encased, 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. Nickle bronze box and hinged cover with operating key lock. NPS 20 mm (¾") hose outlet.  
Zurn Z-1300  
Mifab MHY-20  
Ancon HY-725  
Contour C7100

## 2.5 WATER HAMMER ARRESTORS

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

## 2.6 SOLENOID VALVES

- .1 Two (2) way normally closed all bronze construction.
- .2 Suitable for 0-10VDC or 120V. (Confirm controlling voltage with Div. 16 and/or section 15921 prior to ordering).
- .3 Provide solenoid valves for service indicated.
- .4 Acceptable material:  
Asco

## 2.7 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.

Acceptable materials:

Watts 009 ½" - 2"

Wilkins 975 XL ½" - 2"

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.  
Acceptable materials:  
Watts 909 2½" - 10"  
Wilkins 975 2½"- 10" or 375 4" - 6"  
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.  
Acceptable materials:  
Watts 007 ½"- 2"  
Wilkins 950XL ¾" - 2"  
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.  
Acceptable materials:  
Watts 709 2½" - 10"  
Wilkins 950 2" - 10", 350 4" - 6"  
Conbraco 40-100 Series
- .8 Back flow preventor with intermediate atmospheric vent:  
Acceptable material:  
Watts Series 9D  
Wilkins 750  
Conbraco 40-4A Series

## 2.8 VACUUM BREAKERS

- .1 To CAN/CSA-B64 Series.
- .2 Atmospheric vacuum breaker (A-VB):  
Acceptable materials:  
Watts 288A  
Conbraco 38-103 Series  
Wilkins 35
- .3 Hose connection vacuum breaker (HCVB):  
Acceptable materials:  
Watts Series 8  
Conbraco 38-304-AS  
Wilkins BFP-8
- .4 Laboratory faucet intermediate vacuum breaker (LFVB):  
Acceptable materials:  
Watts N-LF9  
Conbraco 38-502-01

## 2.9 PRESSURE REGULATORS

- .1 Capacity: as indicated.
  - .1 Inlet pressure: 689 kPa (100 psi).
  - .2 Outlet pressure: 482 kPa (70 psi).
- .2 Up to NPS 40 mm (1 1/2") bronze bodies, screwed: to ASTM B62.  
Acceptable material:  
Watts Series 25AUB (1/2" - 2")
- .3 NPS 50 mm (2") and over, semi-steel bodies, Class 125, flanged: to ASTM A126, Class B.  
Acceptable materials:  
Watts PV-10  
Conbraco 36 Series
- .4 Semi-steel spring chambers with bronze trim.
- .5 Acceptable materials:  
Watts PV-10  
Conbraco 36 Series

## 2.10 HOSE BIBBS AND SEDIMENT FAUCETS

- .1 Bronze construction complete with integral back flow preventer, hose thread spout, replaceable composition disc, and chrome plated in finished areas.

Acceptable materials:  
Watts BD series  
Emco  
Chicago  
Zurn

## 2.11 WATER MAKE-UP ASSEMBLY

- .1 Complete with backflow preventor, pressure gauge on inlet and outlet, pressure reducing valve to CSA B356, pressure relief valve on low pressure side and gate valves on inlet and outlet.  
Acceptable materials:  
Watts 911  
Conbraco 35-603-01

## 2.12 WATER METERS (BOILER MAKE UP)

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

## 2.13 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.

## 2.14 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.  
Acceptable materials:  
Watts Series 777SI  
Crane/Powers  
Colton 125 YTB  
Wilkins S Series
- .3 NPS 65 mm (2½") and over, cast iron body, flanged ends, with bolted cap.  
Acceptable materials:  
Watts 77F-D (77F-D-FDA for water service)  
Crane/Powers  
Colton 125 YTB  
Wilkins FS Series

## 2.15 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: as indicated.  
Grease Interceptor #1 3.15 l/s (50 gpm) 80 mm inlet and outlet
- .3 Supply one (1) case of four 1 kg (2.2 lb) cans of enzyme activator with interceptors.
- .4 Acceptable materials:  
Zurn Z-1170 (complete with 2lbs of Biomix powder)  
Mifab  
Ancon

## 2.16 WATER ENTRANCE 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 200°F.
- .3 Acceptable material:  
Amtrol ST-12  
Well-X-Trol
- .4 Tank volume: 24 l (6.4 gallons) with 0.5 acceptance factor.

## 2.17 OWNER SUPPLIED EQUIPMENT

- .1 The mechanical contractor shall supply and install all water, gas, condensate and/or 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.

### **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 NON FREEZE WALL HYDRANTS**

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

#### **3.4 WATER HAMMER ARRESTORS**

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

#### **3.5 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.

### **3.6 BACKWATER VALVES**

- .1 Install where indicated.

### **3.7 HOSE BIBBS AND SEDIMENT FAUCETS**

- .1 Install at bottom of all risers, at low points to drain systems, and as indicated.

### **3.8 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.

### **3.9 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.

### **3.10 STRAINERS**

- .1 Install with sufficient room to remove basket.

### **3.11 INTERCEPTORS**

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

### **3.12 WATER METERS**

- .1 Install water meter(s) provided by local water authority.
- .2 Install water meter(s) as indicated.
- .3 Install remote readout to acceptance of local water authority and as indicated.

### **3.13 WATER MAKE-UP ASSEMBLY**

- .1 Install with valved bypass.

- .2 Pipe discharge from relief valve to nearest floor drain.

### 3.14 WATER ENTRANCE EXPANSION TANK

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

### 3.15 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 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.
  - .3 Cleanouts:
    - .1 Verify covers are gastight, secure and easily removable.
    - .2 Verify that cleanout rods can probe as far as next cleanout.
  - .4 Non-freeze wall:
    - .1 Verify complete drainage.
    - .2 Verify operation of vacuum breaker.
  - .5 Water hammer arrestors:
    - .1 Verify accessibility.
  - .6 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.
  - .7 Pressure regulators:
    - .1 Adjust settings to suit installed locations, required flow rates.
  - .8 Backwater valves:
    - .1 Verify accessibility of cover, valve.
  - .9 Hose bibbs, sediment faucets:
    - .1 verify operation.
  - .10 Water make-up assembly:
    - .1 verify operation.

- .11 Water meters:
  - .1 verify operation.
- .12 Trap seal primers:
  - .1 Verify operation.
  - .2 Adjust flow rate to suit site conditions.
- .13 Pipeline strainers:
  - .1 Verify accessibility of basket.
  - .2 Clean out during commissioning until system clean.
- .14 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**

**1 General**

**1.1 REFERENCES**

- .1 ASTM B32-[89], Specification for Solder Metal.
- .2 ASTM B306-[88], Specification for Copper Drainage Tube (DWV).
- .3 ASTM C564-[88], Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- .4 CSA B67-[1972], Lead Service Pipe, Waste Pipe, Traps, Bends and Accessories.
- .5 CAN/CSA-B70-[M91], Cast Iron Soil Pipe, Fittings and Means of Joining.
- .6 CAN/CSA-B125-[M93], Plumbing Fittings.

**2 Products**

**2.1 COPPER TUBE AND FITTINGS**

- .1 Above ground sanitary, storm, and vent, maximum 65mm (2 ½") Type DWV copper to: ASTM B306.
  - .1 Fittings.
    - .1 Cast brass: to CAN/CSA B125.
    - .2 Wrought copper: to CAN/CSA B125.
  - .2 Solder: tin-lead, 50:50, to ASTM B32, type 50A.

**2.2 CAST IRON PIPING AND FITTINGS**

- .1 Above ground sanitary, storm, and vent, minimum NPS 75 mm (3"), cast iron to: CAN/CSA-B70.
  - .1 Joints.
    - .1 Mechanical joints.
      - .1 Neoprene or butyl rubber compression gaskets: to ASTM C564 or CAN/CSA-B70.
      - .2 Stainless steel clamps.

**2.3 VENT FLASHINGS**

- .1 Altra metal specialties 450 mm (18") high complete with insulation, cap, and rubber gasket (no alternates). Refer to roofing section specified elsewhere.

### 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 15 000 mm (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 +/- 600 mm (24") above roof. Refer to detail. 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 Do not terminate vents within 1500 mm of any building intake and/or exhaust opening.
- .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 80 kg/cu m (5 lb per sq. ft.) lead flashing fitted around pipes and turned down into pipe 13 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 with water and show no leaks for 2 hours.

**END OF SECTION**

**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.

**2 Products**

**2.1 PIPING AND FITTINGS**

- .1 Buried sanitary, storm, 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 fire rated drain waste and vent pipe to CAN/CSA-B181.1.
  - .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 Use plastic XFR – DWV in pipe chase for urinal piping to 1.5 M (5' –0") above finished floor.
- .4 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.

## 3 Execution

### 3.1 INSTALLATION

- .1 Install in accordance with Provincial Plumbing Code and local authority having jurisdiction. Do not use plastic piping above grade for storm piping.
- .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 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.
  
- .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 Install above ground piping parallel and close to walls and ceilings to conserve headroom and space, and to grade as indicated.

**END OF SECTION**

**PAGE INTENTIONALLY LEFT BLANK**

**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.

**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.

**2 Products**

**2.1 GAS FIRED HIGH EFFICIENCY WATER HEATER**

- .1 To ANSI Z21.10.3/CSA 4.3 with a recovery rate of 859 l/h (277 gal/h) based on 56°C (100°F) rise and 58 kW (199 MBH) input. Efficiency of 94%.
- .2 Tank: 378 l (100 gal), glass, lined steel, 692 mm (27¼") dia x 1739 mm (69½") 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 3 year warranty certificate.
- .5 Vent kit complete with wall vent and vent pipe.
- .6 Provide 80 mm (3") ULC S636 approved CPVC piping and fittings for combustion and exhaust. Install as per manufacturers recommendations. Support piping at 1.5 m maximum.
- .7 Provide neutralizing cartridge for each hot water tank as supplied by equipment manufacturer.
- .8 Acceptable materials:  
A. O. Smith Cyclone XI BTH-199  
Ruud  
Bradford White EF-100T-199E

## 2.2 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 200°F.
- .3 Acceptable material:  
Amtrol ST-12  
Well-X-Trol
- .4 Tank volume: 24 l (6.4 gallons) with 0.5 acceptance factor.

## 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 Provide neutralizing cartridge for each tank.
- .4 Thermowell filled with conductive paste for control valve temperature sensor.
- .5 ASME rated temperature and pressure relief valve sized for full capacity of heater, having discharge terminating over floor drain and visible to operators.
- .6 Magnesium anodes adequate for 20 years of operation and located for easy replacement.

## **2.4 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: 120V/1/60, drip-proof, with thermal overload protection.
- .4 Supports: provide as recommended by manufacturer.
- .5 Circulating Pump No. 1 10 gpm 10' HD
- .6 Acceptable materials:  
Armstrong (Model H-32 No.1)  
Bell & Gossett

## **2.5 DOMESTIC WATER THERMOSTATIC WATER CONTROLLER (3 Port)**

- .1 1" inlets 1 ¼ " outlets 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:  
Symmons 6-500A-ASB-W  
Powers  
Leonard

## **2.6 ANCHOR BOLTS AND TEMPLATES**

- .1 Supply for installation by other Divisions.

## **3 Execution**

### **3.1 WATER HEATER**

- .1 Provide two (2) domestic hot water heaters for the High School where indicated.
- .2 Install in accordance with manufacturer's recommendations and authority having jurisdiction.
- .3 Provide structural steel for vertical mounted expansion tanks.
- .4 Provide insulation between tank and supports.

- .5 Provide neutralizing cartridge on each vent drain.
- .6 Install natural gas fired domestic water heaters in accordance with CSA-B149.1-00.

### **3.2 RECIRCULATING PUMPS**

- .1 Provide one (1) recirculating pump for the high school where indicated.
- .2 Make piping and electrical connections to pump and motor assembly and controls as indicated.
- .3 Ensure pump and motor assembly do not support piping.

### **3.3 DOMESTIC HOT WATER EXPANSION TANK**

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

### **3.4 FIELD QUALITY CONTROL**

- .1 Manufacturer's factory trained, certified Technician 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.

**END OF SECTION**

**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 The Ontario Building Code.
  - .3 U.L.C. or Factory Mutual approval for hose, valve and extinguisher requirements.
  - .4 N.F.P.A.10 "Standard for Portable Fire Extinguishers".
  - .5 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.

**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:
- |                             |                                       |
|-----------------------------|---------------------------------------|
| Kitchen                     | Type 'K' 10 lb 20BC rating            |
| Mechanical Rooms            | 10 lb ABC rating                      |
| Storage Rooms               | 10 lb ABC rating                      |
| Corridor/Gym/Finished Areas | 5 lb ABC rating complete with cabinet |

- .2 Acceptable materials:  
Wilson & Cousins  
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:  
Wilson & Cousins Model IE - 105R (5 and 10 lb. Class)  
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 where indicated or directed on site by consultant.
- .5 Manufacturer:  
National FB 4040 blanket  
FB 6078 MC cabinet.

**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 NFPA 96 HOOD**

- .1 20 BC rated fire extinguisher next to each NFPA 96 hood.

**3.4 FIRE BLANKET**

- .1 Hang blanket on wall in cabinet in all Science Rooms and elsewhere as indicated, to manufacturers' recommendations.
- .2 Provide fire blanket next to each NFPA 96 hood mounted on wall.

**END OF SECTION**

**PAGE INTENTIONALLY LEFT BLANK**

**1 General**

**1.1 REFERENCES**

- .1 ANSI/ARI 1010-84, Drinking Fountains and Self-Contained, Mechanically Refrigerated Drinking Water Coolers.
- .2 ANSI/ARI 1020-84, Application and Installation of Drinking-Fountains and Drinking Water Coolers.
- .3 CAN/CSA-B45 Series-88, CSA Standards on Plumbing Fixtures.
- .4 CAN/CSA-B125-93, Plumbing Fittings.
- .5 CAN/CSA-B651-M90, Barrier-Free Design.

**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.

## 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 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 FIXTURE CARRIERS

- .1 Factory manufactured floor-mounted carrier systems for all wall-mounted fixtures.  
Acceptable materials:  
Zurn  
Smith  
Ancon

### 2.3 WATER CLOSET (WC- 1) (Flush Valve)

- .1 Floor-mounted, top spud, ultra-low flush, maximum 3.8 litres/flush.
- .2 Bowl: vitreous china, siphon jet, elongated rim.  
Acceptable materials:  
American Standard Madera  
Koehler  
Crane
- .3 Flush valve: exposed, polished chrome, dual 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.  
Acceptable materials:  
Sloan WES-111  
Zurn  
Delta
- .4 Seat: white, elongated, open front, molded solid plastic, less cover, stainless steel check hinges, stainless steel or solid brass insert post.  
Acceptable materials:  
Bemis 2155C  
Olsonite  
Centoco
- .5 Secure wall plate above flush valve.

**2.4 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.  
Acceptable materials:  
American Standard Madera  
Crane  
Koehler
- .4 Flush valve: exposed, polished chrome, dual 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.  
Acceptable materials:  
Sloan WES-111  
Zurn  
Delta
- .5 Seat: white, elongated, open front with cover, molded solid plastic, cover, stainless steel check hinges, stainless steel or solid brass insert post.  
Acceptable materials:  
Bemis 2150  
Olsonite  
Centoco
- .6 Secure wall plate above flush valve.

**2.5 WATER CLOSETS (WC-3) CHILDCARE (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).  
Acceptable materials:  
American Standard Cadet 3  
Crane  
Kohler
- .4 Seat: white, regular, open front, moulded solid plastic, with cover, stainless steel check hinges, stainless steel or solid brass insert post.  
Acceptable materials:  
Centoco 460 TM  
Bemis  
Olsonite

## 2.6 WATER CLOSETS (WC-4)(16" High Barrier Free Flush Tank)

- .1 Floor-mounted, flush tank, elongated.
- .2 Bowl: 16" high vitreous china, siphon jet, elongated 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 6.0 litres (1.3 gal)/flush).  
Acceptable materials:  
American Standard Cadet 3 right height  
Crane  
Kohler
- .4 Seat: white, elongated, open front, antimicrobial, moulded solid plastic, cover, stainless steel check hinges, stainless steel or solid brass insert post.  
Acceptable materials:  
Centoco  
Bemis  
Olsonite

## 2.7 FLUSH VALVE URINAL (U-1)

- .1 Wall mounted, ultra-low flush, exposed flush valve, top spud.
- .2 Urinal: vitreous china, washout type, integral flushing rim, extended shields, integral trap, back outlet.  
Acceptable materials:  
American Standard Washbrook 6590 001  
Crane  
Koehler
- .3 Manual flush valves: chrome plated, non-hold-open, exposed, diaphragm, externally adjustable, with NPS 20 mm (3/4") angle screwdriver stop, oscillating handle, wall and spud flange, vacuum breaker. Ultra-low flush cycle: set to 1.9 litres flush.  
Acceptable materials:  
Sloan 186  
Zurn  
Delta
- .4 Accessories: removable stainless steel strainer.

## 2.8 WALL HUNG LAVATORY (L-1) SINGLE HANDLE

- .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 x 540 mm (25" x 21 1/2").  
Acceptable materials:  
American Standard Murro  
Crane  
Koehler

- .2 Waste fitting: NPS 32 mm (1 1/4") offset waste with grid strainer.
- .3 Trim:  
Chrome plated brass, blade handed mixing faucet, mixing spout, washerless, aerator.  
  
Provide accessories to limit flow rate to 2 l/min at 413 kPa (60 psi).  
Acceptable materials:  
Zurn Z-7440  
Crane  
Delta

## **2.9 BARRIER FREE WALL HUNG LAVATORY (L-2) SINGLE HANDLE**

- .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 x 540 mm (25" x 21 1/2").  
Acceptable materials:  
American Standard Murro  
Crane  
Koehler
- .2 Waste fitting: NPS 32 mm (1 1/4") offset waste with grid strainer.
- .3 Trim:  
Chrome plated brass, blade handed mixing faucet, mixing spout, washerless, aerator.  
Provide accessories to limit flow rate to 2 l/min at 413 kPa (60 psi).  
Acceptable materials:  
Zurn Z-7440  
Crane  
Delta
- .4 Insulate waste and supplies with UL listed preformed insulation system complete with seamless jacket.  
Acceptable materials:  
McGuire Prowrap  
Truebro

## **2.10 WALL MOUNTED GROUP LAVATORY SYSTEM (L-3) (TWO PERSON)**

- .1 550mm W (22") terreon deck complete with backsplash, front apron, ease edging and contoured trap cover suitable for two (2) users complete with two (2) SL-T01 oval undermount terreon bowls. Contractor to verify counter dimensions on site and coordinate with architectural drawings. Provide side aprons (75 mm (3") high) on exposed edges and 3" (75 mm) high side splashes adjacent walls. Contractor to confirm quantity and location of side splashes and side aprons prior to ordering. Unit complete with stainless steel contoured trap covers and floor mounted concealed wall carrier.

- .2 Trim:  
Chrome plated brass, blade handed mixing faucet, mixing spout, washerless, aerator.
- .3 Waste fitting: NPS 32mm (1¼") offset waste with grid strainer. Provide waste fittings for each user.
- .4 Colour: Colour by architect. Allow for two (2) premium colours.
- .5 Group Lav System to be mounted so top of deck is at 600 mm above finished floor
- .6 Acceptable materials:  
Bradley Omnideck LD-3010-2

## 2.11 WALL MOUNTED LAVATORY SYSTEM (L-4) (ONE PERSON)

- .1 550mm W (22") terreon deck complete with backsplash, front apron, ease edging and contoured trap cover suitable for one (1) user complete with one (1) SL-T01 oval undermount terreon bowl. Contractor to verify counter dimensions on site and coordinate with architectural drawings. Provide side aprons (75 mm (3") high) on exposed edges and 3" (75 mm) high side splashes adjacent walls. Contractor to confirm quantity and location of side splashes and side aprons prior to ordering. Unit complete with stainless steel contoured trap covers and floor mounted concealed wall carrier.
- .2 Trim:  
Chrome plated brass, blade handed mixing faucet, mixing spout, washerless, aerator.
- .3 Waste fitting: NPS 32mm (1¼") offset waste with grid strainer.
- .4 Colour: Colour by architect. Allow for two (2) premium colours.
- .5 Lav System to be mounted so top of deck is at 600 mm above finished floor
- .6 Acceptable materials:  
Bradley Omnideck LD-3010-1

## 2.12 WALL HUNG LAVATORY (L-5) SINGLE HANDLE

- .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: 520 x 464 mm (20 ½" x 18 ¼" ).  
Acceptable materials:  
American Standard Lucerne  
Crane  
Koehler
- .2 Waste fitting: NPS 32 mm (1 1/4") offset waste with grid strainer.

- .3 Trim:  
Chrome plated brass, blade handed mixing faucet, mixing spout, washerless, aerator.

Provide accessories to limit flow rate to 2 l/min at 413 kPa (60 psi).

Acceptable materials:

Zurn Z-7440

Crane

Delta

- .4 Insulate waste and supplies with UL listed preformed insulation system complete with seamless jacket.  
Acceptable materials:  
McGuire Prowrap  
Truebro

- .5 Unit to be mounted so top of unit is at 600 mm above finished floor.

## 2.13 MOP SINKS (MS-1)

- .1 Sink: molded stone, 250 mm (10") high. Size: 600 mm x 600 mm x 250 mm (24" x 24" x 10").  
Acceptable materials:  
Fiat MSB-2424  
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).  
Acceptable materials:  
Fiat 830AA  
Zurn  
Delta

- .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.

**2.14 STAINLESS STEEL SINK SINGLE COMPARTMENT (S-1)**

- .1 Single compartment, ledge-back.  
From 1.0 mm (20 gauge) thick type 302 polished stainless steel, self-rimming, undercoated, clamps. Overall sizes: 520 mm x 510 mm x 180 mm (20" x 20" x 7").  
Acceptable materials:  
Franke LBS 6807  
Elkay
- .2 Trim: chrome plated brass, with swing spout, aerator, single lever handle, washerless controls, accessories to limit flow rate to 2 litres/minute at 413 kPa (60 psi).  
Acceptable materials:  
Delta 100  
Moen  
Zurn
- .3 Waste fitting: integral stainless steel basket strainer/stopper, tailpiece, cast brass P-trap with cleanout.

**2.15 STAINLESS STEEL SINK DOUBLE COMPARTMENT (S-2)**

- .1 Double compartment, ledge-back.  
From 1.0 mm (20 gauge) thick type 302 polished stainless steel, self-rimming, undercoated, clamps. Overall sizes: 790 x 520 x 200 mm (31½" x 20 3/4" x 8").  
Acceptable materials:  
Steel Queen QDL2031/8  
Elkay  
Kindred
- .2 Trim: chrome plated brass, with swing spout, aerator, single lever handle, washerless controls, accessories to limit maximum flow rate to 8.35 l/min (2.2 gpm) at 413 kPa (60 psi).  
Acceptable materials:  
Delta 100  
Moen  
Zurn
- .3 Waste fitting: integral stainless steel basket strainer/stopper, tailpiece, cast brass P-trap with cleanout.

**2.16 STAINLESS STEEL SINK SINGLE COMPARTMENT (S-3)**

- .1 Single compartment, ledge-back.  
From 1.0 mm (20 gauge) thick type 302 stainless steel, self-rimming, undercoated, clamps. Overall sizes: 520 x 510 x 180 mm (20" x 20" x 7").  
Acceptable materials:  
Franke LBS 6807  
Elkay

- .2 Trim: chrome plated brass, with single spout, aerator, single opening, accessories to limit maximum flow rate to 8.35 l/min (2.2 gpm) at 413 kPa (60 psi).  
Acceptable materials:  
Delta 27T143  
Moen  
Zurn
- .3 Waste fitting: integral stainless steel basket strainer/stopper, tailpiece, cast brass P-trap with cleanout.

**2.17 WALL MOUNTED STAINLESS STEEL BARRIER-FREE (S-4) BLADE HANDLES**

- .1 19.0 gauge (1.0 mm) stainless steel, low shelf, with integral back, contoured front, seamless welded bowl (340 x 300 x140), 120 mm tap ledge, front panel with 45° corner edges, rear overflow, soap depressions, supply openings on 100 mm (4") centres, concealed supports complete with satin finish.  
Acceptable materials:  
Franke WT400C-8  
Elkay  
Steel Queen
- .2 Waste fitting: NPS 32 mm (1 1/4") offset waste with grid strainer.
- .3 Trim:  
Heavy duty cast brass faucet complete with polished chrome plated finish, 8" tubular swing spout on 100 mm (4") centres, knee shroud, aerator, blade handles with indexed buttons.  
Provide accessories to limit maximum flow rate to 8.35 l/min (2.2 gpm) at 413 kPa (60 psi).  
Acceptable materials:  
Delta 27C4243  
Zurn  
Crane
- .4 Insulate waste and supplies with UL listed preformed insulation system complete with seamless jacket.  
Acceptable materials:  
McGuire Prowrap  
Truebro

**2.18 BARRIER-FREE NON-REFRIGERATED 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. Unit shall include pushbar-activation and water-efficient bubbler. 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, and wall hanger.

- .2 Trim: vandal resistant, angle stream anti-squirt bubbler with automatic stream regulator, self-closing push button valve, screwdriver stop, waste tailpiece, trap and access cover.  
Acceptable materials:  
Oasis PSBF (No alternates)

## 2.19 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 Acceptable materials:  
Haws 7260BT and Mixing Valve TWBS-EWE  
Bradley  
Guardian

## 2.20 WASHER SUPPLY (WS-1)

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

## 2.21 FIXTURE PIPING

- .1 Hot and cold water supplies to each fixture:  
Chrome plated flexible supply pipes each with screwdriver stop, reducers, escutcheon and chrome plated nipple.  
Acceptable materials:  
Delta 47T900 Series  
McGuire
- .2 Waste:  
Open grid strainer, or pop up as indicated, offset open grid strainer on handicapped fixtures, cast brass fittings with tubular piping, chrome plated, rubber gasket compression fitting, and overflow flange.  
Acceptable materials:  
Delta 33T200 Series  
McGuire

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

### **3 Execution**

#### **3.1 INSTALLATION**

- .1 Mounting heights:
  - .1 Standard: to comply with manufacturer's recommendations unless otherwise indicated or specified.
  - .2 Wall-hung fixtures: measured from finished floor.
  - .3 Physically handicapped: to comply with most stringent of either NBCC or CAN/CSA B651.
- .2 Drinking fountains:
  - .1 In accordance with ANSI/ARI 1020.

#### **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 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.
- .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**

**PAGE INTENTIONALLY LEFT BLANK**

**1 General**

**1.1 RELATED SECTIONS**

- .1 Submittals.
- .2 Shop Drawings, Product Data, Samples and Mark-ups.
- .3 Pipe Hangers and Supports.

**1.2 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-[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 C 335, Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
  - .2 ASTM C 449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
  - .3 ASTM B 209M, Specification for Aluminum and Aluminum Alloy Sheet and Plate.
- .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): National Insulation Standards.

**1.3 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.

#### **1.4 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.

#### **1.5 QUALIFICATIONS**

- .1 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.

#### **1.6 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.
- .2 Insulation systems - insulation material, fasteners, jackets, and other accessories.

### **2 Products**

#### **2.1 FIRE AND SMOKE RATING**

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

## 2.2 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 C 335.
- .3 Type C-1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma:
  - .1 Mineral fibre: to ASTM C553.
  - .2 Jacket: to CGSB 51-GP-52 Ma.
  - .3 Maximum "k" factor: to ASTM C553.
- .4 Type C-2: Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma:
  - .1 Mineral fibre: to ASTM C553.
  - .2 Jacket: to CGSB 51-GP-52 Ma.
  - .3 Maximum "k" factor: to ASTM C553.
- .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.
- .6 Manufacturers:
  - .1 All materials must be supplied by the same manufacturer.
  - .2 Acceptable Materials:
    - Johns Manville
    - Fibreglass Canada
    - Knauf
    - Manson
    - Roxul

## 2.3 JACKETS

- .1 Canvas:
  - .1 220 g/m<sup>2</sup> (0.0451 lb/ft<sup>2</sup>) cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.
  - .2 Lagging adhesive: Compatible with insulation.

## 2.4 ACCESSORIES

- .1 Vapour retarder lap adhesive:
  - .1 Water based, fire retardant type, compatible with insulation.
- .2 Indoor Vapour Retarder Finish:
  - .1 Vinyl emulsion type acrylic, 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> (0.0451 lb/ft<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 Duro Dyne 1A-22 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.

### **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 TIAC National Standards.
- .2 Apply materials in accordance with manufacturer's 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.

### 3.3 DUCTWORK INSULATION SCHEDULE

- .1 Insulation types and thickness' to conform to following tables:

<u>Application</u>	<u>Type</u>	<u>Thickness</u>
Rectangular supply air ducts	C-1	25 mm (1")
Round supply air ducts	C-2	25 mm (1")
Supply, return and 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	
Last 1.5m of Exhaust duct	C-1	25 mm (1")
Indoor AHU relief air ducts	C-1	25 mm (1")
Fire rated duct wrap	C-3	50 mm (2")

- .2 Finishes: Conform to following table:

<u>Application</u>	<u>Rectangular</u>	<u>Round</u>
Indoor, concealed	none	none
Indoor, exposed	Canvas	Canvas

### 3.4 FIRE BARRIER DUCT WRAP INSTALLATION

- .1 The Fire Barrier Duct Wrap 15A and 3M Fire Barrier 1000 N/S, 1003 S/L and 2000+ Silicone Sealants must be stored in a dry warehouse environment. Pallets should not be stacked.
- .2 In order to install the duct firestop system, the surfaces of all the openings and penetrating items need to be clean, dry, frost free and free of dust.
- .3 The 3M Fire Barrier Duct Wrap 15A blanket shall be wrapped around the perimeter of the duct and is cut to a length to overlap itself not less than 3 in. (76 mm). The overlap made by adjacent blankets shall form the "longitudinal" overlap. Aluminum foil tape is used to seal all cut edges of the blanket and any tears in the foil scrim.
- .4 Filament tape can be used to temporarily hold the blanket in place until the banding is applied. The steel banding is applied around the duct 1-1/2 in. (38 mm) from each edge of the blanket, and maximum 10-1/2 in. (26.7 cm) centers. The banding is placed around the material and tightened so as to sufficiently hold the 3M Fire Barrier Duct Wrap 15A in place against the duct, compressing the foil but not cutting the foil.
- .5 Additional Pinning to Prevent Sagging of the Wrap: For Ducts 24 in. (60 cm) and larger in width, additional pins are needed to support the blanket on the bottom horizontal surface and on the outside face of a vertical duct run. Space pins a maximum of 10-1/2 in. (26.7 cm) apart in the direction of the blanket width, and a maximum of 12 in. (30 cm) apart in the direction of the blanket length.
- .6 Support hanger systems shall be external of the duct wrap.

- .7 Provide four galvanized steel threaded rods, ¼ in. diameter (6,35 mm) by 4-1/2 in. to 5 in. long (114 mm to 127 mm) are welded to the duct at the corners of the door opening. Four steel tubes, each 3 in. (76 mm) long, are placed over the rods to act as protection for the 3M Fire Barrier Duct Wrap 15A when fastening the door. Four installation pins are welded to the door panel for installation of the blanket. One layer of 3M Fire Barrier Duct Wrap 15A shall be cut approximately the same size as the access panel and impaled over the insulation pins on the panel.
- It is essential that this layer fit tightly against the wrap surrounding the access door opening with no through openings. A second layer of 3M Fire Barrier Duct Wrap 15A shall be cut so as to overlap the first layer by a minimum of 1 in. (25,4 mm). The second layer is impaled over the pins and both layers are locked in place with galvanized speed clips.
- Pins that extend beyond the outer layer of 3M Fire Barrier Duct Wrap 15A shall be turned down to avoid sharp points on the door.
- .8 When the duct penetrates a fire rated wall, ceiling or floor, an approved firestop system must be constructed to manufactures recommendation.

**END OF SECTION**

**1 General**

**1.1 REFERENCES**

- .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible-[1985].
- .2 CGSB 51-GP-10M-[76], Thermal Insulation, Mineral Fibre, Block or Board, for Ducting, Machinery and Boilers.
- .3 ANSI/NFPA 90A-[1989], Installation of Air Conditioning and Ventilating Systems.
- .4 ANSI/NFPA 90B-[1989], Installation of Warm Air Heating and Air Conditioning Systems.

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with general requirements.

**2 Products**

**2.1 DUCT LINER**

- .1 General:
  - .1 Greenguard certified rigid fibrous glass duct liner: air stream side faced with mat facing.
  - .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102.
  - .3 Acceptable material:
    - Johns Manville, Linacoustic RC
    - Owen Corning
- .2 Flexible:
  - .1 25 mm (1") thick, to CGSB-51-GP-11M, fibrous glass blanket duct liner.
  - .2 Density: 24 kg/minimum.
  - .3 Thermal resistance to be minimum 0.74 m (2'6").C/W for 25 mm thickness when tested in accordance with ASTM C177, at 24C mean temperature.

**2.2 ADHESIVE**

- .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 minus 29C to plus 93C.

- .3 Acceptable materials:  
Duro Dyne 1A-22  
Ductmate

## 2.3 FASTENERS

- .1 Weld pins 2.0 mm (13 gauge) diameter, length to suit thickness of insulation. Metal retaining clips, 32 mm (1 1/2") square.
- .2 Acceptable materials:  
Duro Dyne PL-PC  
Ductmate

## 2.4 JOINT TAPE

- .1 Poly-Vinyl treated open weave fiberglass membrane 50 mm (2") wide.
- .2 Acceptable materials:  
Duro Dyne FT2  
Ductmate

## 2.5 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 minus 68C to plus 93C.
- .3 Acceptable materials:  
Duro Dyne 1A-94  
Ductmate

## 3 Execution

### 3.1 GENERAL

- .1 Do work in accordance with recommendations of SMACNA duct liner standards as indicated in SMACNA HVAC Duct Construction Standards, Metal and Flexible, except as specified otherwise.
- .2 Line inside of ducts where indicated.
- .3 Duct dimensions, as indicated, are clear inside duct lining.

### 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.

### 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**

PAGE INTENTIONALLY LEFT BLANK

**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, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded 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 manufacturer's catalogue literature.

**1.3 CLOSEOUT SUBMITTALS**

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

## 2 Products

### 2.1 GAS SERVICE

- .1 Arrange with the local utility to have the additional gas service provided to the gas meter where indicated.
- .2 Fees and charges requested by the local utility to provide the gas service and meter will be by cash allowance. Refer to Division 1.
- .3 Submit all plans as requested by the local utility.

### 2.2 PIPE

- .1 Steel pipe: to ASTM A53/A53M, 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.
- .4 Flexible gas pipe: ASTM A240 CSA/ULC approved corrugated 304 stainless steel piping to ASTM A240 with UV resistant polyethylene jacket to ASTM E84. Fittings to ASTM B16 Type 360 Brass. Provide end fittings to suit connections. Provide restraint strap on all kitchen equipment.

### 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.
- .2 Copper pipe fittings, screwed, flanged or soldered:
  - .1 Cast copper fittings: to ANSI B16.18.
  - .2 Wrought copper fittings: to ANSI/ASME B16.22.
- .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:
    - Newman Hattersley
    - Crane
    - Jenkins

## 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:  
Quick Block  
Erico

## **2.9 PIPING THROUGH ROOF**

- .1 Provide Thaler MEF-9 or equal gas piping flashing where pipe and/or relief vent penetrates roof.

## **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 all 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:  
≤ 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 SERVICES**

- .1 It is the responsibility of this contractor to arrange with local gas distributor to install the gas service and gas meter where indicated.

**END OF SECTION**

**1 General****1.1 REFERENCES**

- .1 ANSI/ASME B40.1-1990, Gauges-Pressure, Indicating Dial Type-Elastic Element.
- .2 CAN/CGSB-14.4-M88, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.
- .3 CAN/CGSB-14.5-M88, 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 clocks.
  - .4 Syphons.
  - .5 Wells.

**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:
    - Trerice
    - Winters 91T
    - Wiess

**2.3 THERMOMETER WELLS**

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

## 2.4 PRESSURE GAUGES

- .1 112 mm (4 1/2"), dial type: to ANSI/ASME B40.1, Grade 2A, stainless steel phosphor bronze bourdon tube having 0.5% accuracy full scale unless otherwise specified.
  - .1 Acceptable materials:
    - Winters
    - Trerice
    - 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.

## 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 Water boilers.
  - .2 DHW tanks.
  - .3 HWS and HWR headers.
- .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 Outlet of boilers.
  - .4 Outlet of compressors.
  - .5 In other locations as indicated.
  - .6 Inlet and outlet of water meters.
  - .7 Inlet and outlet of backflow prevention.
- .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 lamicoïd nameplates as specified in elsewhere identifying medium.

**END OF SECTION**

**PAGE INTENTIONALLY LEFT BLANK**

## **1 General**

### **1.1 REFERENCES**

- .1 American Society for Testing and Materials
  - .1 ASTM A53-[90b], Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
  - .2 ASTM A105/A105M-[92], Specification for Forgings, Carbon Steel, for Piping Components.

### **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.

## **2 Products**

### **2.1 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.
  - .2 Working temperature: 250 C.
  - .3 To match system requirements.

## 2.2 ANCHORS AND GUIDES

- .1 Alignment guides:
  - .1 Provide on radiation with expansion compensators.
  - .2 Vapour barriers, jackets to remain uninterrupted.

## 2.3 EXPANSION COMPENSATORS (EXP)

- .1 Provide on radiation where indicated.
- .2 Packless guided construction complete with multi ply stainless steel bellows.
- .3 Operating temperature (750°F).
- .4 Operating pressure 36 kpa (250 psi).
- .5 Provide Model H-3 for steel pipe and Model HB for copper pipe
- .6 Acceptable material:  
Senior Flexonics

## 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 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 on radiation heating element including return piping in cabinet.

### **3.3 THERMAL EXPANSION**

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

**END OF SECTION**

**PAGE INTENTIONALLY LEFT BLANK**

**1 General**

**1.1 REFERENCES**

- .1 Canadian Standards Association (CSA).
  - .1 CSA W47.1-[92], Certification of Companies for Fusion Welding of Steel Structures.
  - .2 CSA W47.1S1-[M1989], Supplement No. 1-M1989 to W47.1-1983, Certification of Companies for Fusion Welding of Steel Structures.
  
- .2 American National Standards Institute (ANSI).
  - .1 ANSI/ASME B16.1-[1989], Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.
  - .2 ANSI/ASME B16.3-[1985], Malleable-Iron Threaded Fittings, Classes 150 and 300.
  
- .3 American Society for Testing and Materials (ASTM).
  - .1 ASTM A47M-[90], Specification for Ferritic Malleable Iron Castings.
  - .2 ASTM A53-[90b], Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
  - .3 ASTM A536-[84], Specification for Ductile Iron Castings.
  - .4 ASTM B61-[90], Specification for Steam or Valve Bronze Castings.
  - .5 ASTM B62-[90], Specification for Composition Bronze or Ounce Metal Castings.
  - .6 ASTM E202-[88], Test Method for Analysis of Ethylene Glycols and Propylene Glycols.
  
- .4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
  - .1 MSS-SP-67-[1990], Butterfly Valves.
  - .2 MSS-SP-70-[1984], Cast Iron Gate Valves, Flanged and Threaded Ends.
  - .3 MSS-SP-71-[1984], Cast Iron Swing Check Valves, Flanged and Threaded Ends.
  - .4 MSS-SP-80-[1987], Bronze Gate, Globe, Angle and Check Valves.
  - .5 MSS-SP-85-[1985], 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:
  - Piping
  - Valves
  - Accessories

### 1.3 CLOSEOUT SUBMITTALS

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

## 2 Products

### 2.1 PIPE

- .1 Steel pipe: to ASTM A53, Grade B, as follows:
  - .1 NPS 150 mm (6"), Schedule 40.

### 2.2 PIPE JOINTS

- .1 NPS 50 mm (2") and under: screwed fittings with pulverized lead paste.
- .2 NPS 65 mm (2-1/2") and over: welding fittings and flanges to CSA W47.1 and CSA W47.1S1.
- .3 Flanges: plain or raised face, slip-on.
- .4 Flange gaskets: to ANSI/AWWA C111/A21.11.
- .5 Pipe thread: taper.
- .6 Bolts and nuts: to ANSI B18.2.1 and ANSI/ASME B18.2.2.

### 2.3 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 A47M and ANSI/ASME B16.3.

## 2.4 VALVES MANUFACTURERS

- .1 All valves shall be of commercial grade and of same manufacturer.
- .2 Acceptable Manufacturers:  
Newman Hattersley Canada Ltd.  
Jenkins/Crane  
Milwaukee  
Toyo  
KITZ

## 2.5 VALVES

- .1 Connections:
  - .1 NPS 50 mm (2") and smaller: screwed ends.
  - .2 NPS 65 mm (2 ½") 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. Jenkins 810J.
    - .2 Elsewhere: Class 125, non-rising stem, solid wedge disc. Jenkins 310J.
  - .2 NPS 65 mm (2 1/2") and over:
    - .1 Mechanical Rooms:
      - .1 Rising stem, solid wedge disc, bronze trim. Jenkins 454J.
        - .1 Operators: hand wheel
      - .2 Non-rising stem, solid wedge disc, bronze trim. Jenkins 452J.
        - .1 Operators: hand wheel.
- .3 Butterfly valves: Application: Isolating each cell or section of multiple component equipment and where indicated.
  - .1 NPS 100 mm (4") and over: Flanged ends. Jenkins FIG 2232 ELJ.
- .4 Globe valves: Application: Throttling, flow control, emergency bypass:
  - .1 NPS 50 mm (2") and under:
    - .1 With PFTE disc, as specified. Jenkins 106BJ.  
Bronze.
  - .2 NPS 65 mm (2 1/2") and over:
    - .1 With solid bronze disc, bronze trim, cast iron body. Jenkins 2342.
- .5 Balancing, for TAB:
  - .1 All sizes: Calibrated balancing valves, capacity as indicated.
  - .2 Acceptable material:  
Bell & Gossett Model CB  
Taco  
Armstrong
- .6 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc, with chain and cap.

- .7 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. Jenkins 587J.
  
- .8 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: Screwed ends to ANSI B1.20.1 and with hex. shoulders.
    - .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.
    - .9 Jenkins 201SJ.

## 2.6 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 NPT tapped drain/purge ports, memory stop and calibrated nameplate.
- .4 Acceptable materials:  
Bell & Gossett Circuit Setters  
Armstrong

## 2.7 AUTOMATIC AIR VENT

- .1 Industrial float vent: cast iron body and NPS 15 mm (1/2") connection and rated at 860 kPa working pressure.
- .2 Float: solid material suitable for 115C working temperature.
- .3 Plastic vents are not acceptable.
- .4 Acceptable material:  
Maid-O-Mist No. 67  
Spirax Sarco

### **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 (2 1/2") 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 cock valve on automatic air vent inlet.

### **3.4 CIRCUIT BALANCING VALVES**

- .1 Install flow measuring stations and flow balancing valves as indicated.
- .2 Install to manufacturers requirements.
- .3 Tape joints in prefabricated insulation on valves installed in chilled water mains.
- .4 Valve size shall be one trade size smaller than piping.

### **3.5 FLUSHING AND CLEANING**

- .1 Procedure:
  - .1 Flushing and cleaning should only take place after successful piping pressure testing.
  - .2 Terminal device (AHU coils, VAV coils, radiation, etc.) 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.
- .2 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.
- .3 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.
- .4 Coordinate flushing and cleaning of mechanical systems with HVAC water treatment contractor.

- .5 Flush and clean new piping system in presence of Consultant.
- .6 Flush after pressure test for a minimum of 4 hrs.
- .7 Fill system with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8 hrs.
- .8 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.
- .9 During circulation of cleaning solution, periodically examine and clean filters and screens and monitor changes in pressure drop across equipment.
- .10 Refill system with clean water. Circulate for at least 2 hours. Clean out strainer screens/baskets regularly. Then drain.
- .11 Drainage to include drain valves, dirt pockets, strainers, every low point in system.
- .12 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.
- .13 Re-install strainer screens/baskets only after obtaining Consultant's approval and approval from HVAC water treatment contractor.
- .14 Repeat system drain and flush as often as necessary to have a clean system.
- .15 Disposal of cleaning solutions to be approved by authority having jurisdiction.
- .16 Isolate new piping system from existing system as required for system cleaning.
- .17 After system is cleaned, refill chilled water and hot water heating system with clean water and chemical as per chemical supplier treatment.
- .18 After system is cleaned, refill glycol piping system with 40% glycol solution.

### **3.6 TESTING**

- .1 Test system in accordance with Section 15010 - Mechanical General Requirements.
- .2 For glycol systems, retest with propylene glycol (Eco-fluid) to ASTM E202, inhibited, for use in building system after cleaning.

**3.7 BALANCING**

- .1 Balance water systems to within plus or minus 5% of design output.
- .2 Refer to Section 15950 - Testing Adjusting and Balancing for applicable procedures.

**3.8 GLYCOL CHARGING**

- .1 Provide mixing tank and positive displacement pump for initial glycol charging.
- .2 Retest for concentration to ASTM E202 after cleaning.
- .3 Provide report to Consultant.
- .4 Maintain glycol level in storage tank until system is fully charged and has equalized throughout the entire system. Monitor system on bi-weekly basis until system is completely filled.

**END OF SECTION**

## **1 General**

### **1.1 REFERENCES**

- .1 Canadian Standards Association (CSA).
  - .1 CSA B51-[M1991], Boiler, Pressure Vessel, and Pressure Piping Code.
- .2 American Society for Testing and Materials (ASTM).
  - .1 ASTM A47M-[90], Specification for Ferritic Malleable Iron Castings [Metric].
  - .2 ASTM A278M-[85(1991)], Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 345C [Metric].
  - .3 ASTM A516/A516M-[90], Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
  - .4 ASTM A536-[84], Specification for Ductile Iron Castings.
  - .5 ASTM B62-[93], Specification for Composition Bronze or Ounce Metal Castings.
- .3 American Society of Mechanical Engineers (ASME).
  - .1 ANSI/ASME, Boiler and Pressure Vessels Code (BPVC)

### **1.2 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with general requirements.
- .2 Indicate on product data expansion tanks, air vents, separators, valves, strainers.

### **1.3 CLOSEOUT SUBMITTALS**

- .1 Submit maintenance data in accordance with general requirements.

## **2 Products**

### **2.1 DIAPHRAGM TYPE EXPANSION TANK**

- .1 Vertical galvanized steel pressurized diaphragm type expansion tank.
- .2 Diaphragm sealed in EPDM suitable for 115°C (240°F) operating temperature.
- .3 Working pressure: 860 kPa (125 psi) with ASME stamp and certification.
- .4 Air precharged to 84 kPa (12 psi) (initial fill pressure of system).
- .5 Base mount for vertical installation.
- .6 Acceptable material:  
Heating Water: Extrol Model AX200V One (1) required

## **2.2 COMBINATION LOW PRESSURE RELIEF AND REDUCING VALVE**

- .1 Adjustable pressure setting: 206 kPa relief, 55 to 172 kPa reducing.
- .2 Low inlet pressure check valve.
- .3 Removable strainer.

## **2.3 PIPE LINE STRAINER**

- .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.
- .4 Blowdown connection: NPS 25 mm (1").
- .5 Screen: stainless steel with 1.19 mm (19 gauge) perforations.
- .6 Working pressure: 860 kPa.

## **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 tapings 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 of each pump.
- .4 Install ahead of each automatic control valve larger than NPS 25 mm (1") and as indicated.

### **3.3 EXPANSION TANKS**

- .1 Provide expansion tank as indicated.
- .2 Adjust expansion tank pressure to suit design criteria.
- .3 Install lockshield type valve at inlet to tank.

### **3.4 PRESSURE SAFETY RELIEF VALVES**

- .1 Run discharge pipe to terminate above nearest drain.

**END OF SECTION**

**PAGE INTENTIONALLY LEFT BLANK**

**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.

**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.
- .4 Seal assembly: mechanical for service to 135C.
- .5 Coupling: flexible self-aligning.
- .6 Motor: resilient mounted, drip proof, sleeve bearing, as indicated.
- .7 Capacity: as indicated.
- .8 Design pressure: 1207 kPa.
- .9 Acceptable materials:  
Armstrong Series 1060  
B & G Series 60

### **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 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.
- .3 Pipe drain tapping to floor drain.
- .4 Install volute venting pet cock in accessible location.
- .5 Check rotation prior to start-up.
- .6 Install pressure gauge with plug cocks on inlet and outlet on pump.

**END OF SECTION**

**1 General**

**1.1 RELATED SECTIONS**

- .1 Section 15401 - Plumbing Specialties and Accessories.

**1.2 REFERENCES**

- .1 American Society of Mechanical Engineers (ASME).
- .2 ANSI/ASME Boiler and Pressure Vessel Code, Section VII-1992.

**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.

**2 Products**

**2.1 MANUFACTURER**

- .1 Equipment, chemicals, service by one supplier.
- .2 Acceptable manufacturer:  
Control Chem Canada: Rob Baker – (905) 319-2234

**2.2 POT FEEDER**

- .1 Welded steel, pressure rating 1200 kPa. Temperature rating: 90C.

### **2.3 CHEMICAL FEED PIPING**

- .1 Resistant to chemicals employed. Pressure rating: 1200 kPa.

### **2.4 CHEMICAL FEED PUMPS**

- .1 Top-mounted electronic metering diaphragm type: flow range 0-100%, adjustable, plus or minus 1.0% accuracy (repetitive), on-off operation, with pressure relief valve, check valve, foot valve, injection fitting.
- .2 Piston type: flow range 0-100%, adjustable, plus or minus 1.0% accuracy (repetitive), on-off operation, with stainless steel piston, pressure relief valve, double ball and check valves.

### **2.5 SHIPPING/ FEEDING CHEMICAL CONTAINERS**

- .1 High density moulded polyethylene, with liquid level graduations, cover.
- .2 Agitators: as required by manufacturer.

### **2.6 CONDUCTIVITY CONTROLLER**

- .1 Fully transistorized, suitable for wall or flush panel mounting, linear over full measuring range of 0-5000 micromhs.
- .2 Insensitive to phase angle shifts, capable of operating on 95-130 Volts without affecting accuracy, power, bleedoff status lights.

### **2.7 CONDUCTIVITY PROBES**

- .1 Dual carbon elements in PVC holder, quick disconnect, self-locking connection.

### **2.8 WATER TREATMENT FOR HYDRONIC SYSTEMS**

- .1 Hot water heating system: Pot feeder, 19 l (5 gal).
- .2 Micron filter for each pot feeder:
  - .1 Capacity 2% of pump recirculating rate at operating pressure.
  - .2 Six (6) sets of filter cartridges for each type, size of micron filter.
- .3 Balancing valve set for 2% pump capacity.

### **2.9 CHEMICALS**

- .1 Provide 1 year's supply.

**2.10 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.

**2.11 CLEANING CHEMICALS**

- .1 Provide as required to make system clean.
- .2 Cleaner chemical: compatible and of the same manufacturer of the water treatment supplier.

**2.12 RECORD MANAGEMENT**

- .1 Provide cards and card holder mounted on wall adjacent to each pot feeder.

**3 Execution**

**3.1 INSTALLATION**

- .1 Install HVAC water treatment systems in accordance with ASME Boiler Code Section VII, and requirements and standards of authorities having jurisdiction, except where specified otherwise.
- .2 Ensure adequate clearances to permit performance of servicing and maintenance of equipment.

**3.2 CHEMICAL FEED PIPING**

- .1 Install crosses at all changes in direction. Install plugs in all unused connections.

**3.3 CLEANING OF MECHANICAL SYSTEM**

- .1 Coordinate cleaning of each mechanical piping systems with mechanical contractor.
- .2 Provide copy of recommended cleaning procedures and chemicals for approval by Consultant.

- .3 Thoroughly flush all 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.
- .4 During circulation of cleaning solution, periodically examine and clean filters and screens and monitor changes in pressure drop across equipment.
- .5 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.
- .6 Disposal of cleaning solutions to be approved by authority having jurisdiction.

### 3.4 WATER TREATMENT SERVICES

- .1 Provide monthly water treatment monitoring and consulting services for period of one year after system start-up. Service to include:
  - .1 Initial water analysis and treatment recommendations.
  - .2 System start-up assistance.
  - .3 Operating staff training.
  - .4 Visit plant every 7 days during period of operation and as required until system stabilizes, and advise on treatment system performance. Provide monthly visits with reports after system has stabilized to the satisfaction of the Owner.
  - .5 Provide monthly recording charts and log sheets for one year operation.
  - .6 Provide necessary laboratory and technical assistance.
  - .7 Instructions and advice to operating staff to be clear, concise and in writing.

### 3.5 START-UP

- .1 Start up water treatment systems in accordance with manufacturer's instructions.

### 3.6 COMMISSIONING

- .1 Commissioning Agency: To be 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 specified 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 Commissioning procedures - Closed Hydronic Systems:
  - .1 Analyze water in system.
  - .2 Based upon an assumed rate of loss approved by Engineer, establish rate of glycol feed.
  - .3 Charge system with water and chemical or as specified elsewhere 40% propylene glycol solution.
  - .4 Record types, quantities of chemicals applied.
- .6 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.
- .7 Certificates:
  - .1 Upon completion, furnish certificates confirming satisfactory installation and performance.
- .8 Commissioning Reports:
  - .1 To include system schematics, test results, test certificates, raw and treated water analyses, design criteria, all other data required by Consultant.
- .9 Commissioning activities during Warranty Period:
  - .1 Check out water treatment systems on regular basis and submit written report to Consultant.

**END OF SECTION**

PAGE INTENTIONALLY LEFT BLANK

**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.
- .8 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 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.

## 2 Products

### 2.1 DUCTWORK

#### .1 Galvanized Steel:

- .1 Galvanized steel with Z90 designation zinc coating lock forming quality: to ASTM A653/A653M. All exposed ductwork shall be complete with satin coat finish.
- .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 Black Steel

- .1 To ASTM A6653/A653M.
- .2 Thickness: 1.2 mm (18 gauge)
- .3 Fabrication: ducts and fittings to ASHRAE and SMACNA.
- .4 Reinforcement: as indicated.
- .5 Joints: continuous weld.

#### .3 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:  
Ductmate Canada Ltd.
- .4 Foil tape all transvers 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.  
Acceptable materials:  
Ductmate Canada Ltd.  
Nexus, Exanno Corp.  
WDCI
- .4 Ducts 1200 mm (48") and larger, Ductmate/35, Nexus, or WDCI (heavy) (SMACNA "J" Type connection). Weld all corners.  
Acceptable materials:  
Ductmate Canada Ltd.  
Nexus, Exanno Corp.  
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: in exposed areas one-piece smooth radius, 1.5 times diameter.  
: 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
2500 (10")	A
1500 (6")	A
1000 (4")	A
750 (3")	A
500 (2")	B
250 (1")	B
125 (0.5")	C

- .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).
  - .1 Acceptable materials:
    - Duro Dyne S-2
    - Foster

## 2.6 TAPE

- .1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm (2") wide.
  - .1 Acceptable material:
    - 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 Fresh air intake.
  - .2 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 Trapeze hangers: ducts over 500 mm (20") diameter or longest side, to ASHRAE and SMACNA.
- .3 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)

- .4 Upper hanger attachments:
  - .1 For concrete: manufactured concrete inserts.
    - .1 Acceptable material  
Myatt fig. 485
  - .2 For steel joist: manufactured joist clamp or steel plate washer.
    - .1 Acceptable material:  
Grinnell fig. 61 or 60

- .3 For steel beams: manufactured beam clamps:
  - .1 Acceptable material:  
Grinnell Fig. 60

**3 Execution**

**3.1 GENERAL**

- .1 The following systems shall conform to these requirements:

System	Class	Material
Exhaust Hoods	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 or aluminum as indicated.
Individual Exhaust	C	Galvanized steel or aluminum as indicated.
Kitchen Exhaust	Welded	Black 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 WATERTIGHT DUCT**

- .1 Slope horizontal branch ductwork down towards building exterior.
- .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.

### **3.4 KITCHEN EXHAUST SYSTEMS**

- .1 Install to ANSI/NFPA 96 and as indicated.
- .2 Provide smoke test on exhaust ductwork and system to the local authority's requirements and report to the consultant in writing.
- .3 Provide all other tests test on exhaust system to the local authorities' requirements and report to the consultant in writing.

### **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. 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 2" w.c. (500 Pa) 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 Ensure all systems are clean prior to start up.

**END OF SECTION**

**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.

**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.
- .5 Acceptable materials:  
Nailor  
E. H. Price  
Titus
- .6 Provide access doors in kitchen exhaust duct with bolted cover to the requirements of NFPA and authority having jurisdiction.

## 2.4 TURNING VANES

- .1 Factory or shop fabricated double thickness, to recommendations of SMACNA and as indicated.
- .2 Acceptable materials:  
Duro Dyne  
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:  
Duro Dyne IP1 or IP2  
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:  
Greenheck GPR – 600 mm (24") high  
Penn

## 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 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.
- .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.

**END OF SECTION**

**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.

**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: 50 mm (2") up to 375 mm (15") high duct.  
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:
  - Duro Dyne
  - National Controlled Air (NCA)
  - Nailor
  - T.A. Morrison
  - Tamco
  - Ruskin
  - Ventex/Alumavent
  - United Eneritech

## 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:
  - Duro Dyne
  - Ductmate

## **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
  - EH Price AE-1

## **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.
  - Single blade dampers up to 200 mm (8").
  - 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.

**END OF SECTION**

**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 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 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.

## 2 Products

### 2.1 FIRE DAMPERS (STATIC)

- .1 Fire dampers: arrangement as indicated, listed and bear label of ULC, meet requirements of provincial fire authority and authorities having jurisdiction. Fire damper assemblies to be fire tested in accordance with CAN/ULC-S112.
- .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 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.
- .5 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.
- .6 Acceptable materials:
  - Ruskin
  - Nailor
  - National Controlled Air (NCA)
  - T.A. Morrison
  - Tamco
  - Ventex/Alumavent
  - United Enertech
  - Safeair-Dowco (stainless steel)
  - Greenheck
  - Alumavent

### 2.2 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:
  - Ruskin
  - Nailor
  - National Controlled Air (NCA)
  - T.A. Morrison
  - Tamco
  - Greenheck
  - Alumavent

### **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 ductwork where air is moved by a fan/blower.

**END OF SECTION**

**PAGE INTENTIONALLY LEFT BLANK**

**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.

**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: By to BAS contractor.

- .6 Performance:
  - .1 Leakage: in closed position to be less than 2% of rated air flow at 250 kPa (36 psi) differential across damper.
  - .2 Pressure drop: at full open position to be less than 100 kPa (15 psi) 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.
  
- .8 Acceptable materials:
  - Tamco
  - Alumavent

## **2.2 BACK DRAFT DAMPERS**

- .1 Automatic gravity operated, multi leaf, aluminum construction with nylon bearings, centre pivoted or counterweighted, as indicated.
  
- .2 Acceptable materials:
  - T.A. Morrison
  - Tamco Series 7000
  - Alumavent

## **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.

**END OF SECTION**

**1 General**

**1.1 REFERENCES**

- .1 ASTM A526/A526M-[90], Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality.
- .2 ASTM C423-[90a], Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
- .3 ASTM E90-[90], Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.
- .4 ASTM E477-[90], 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.

**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 (2 ") 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: 1.0 mm (20 gauge) 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 600 mm (24") 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 indicated.
- .2 Assembly:
  - .1 Panel and flashing joints externally sealed with 6 mm (1/4") diameter bead of non sag, non hardening sealant.
  - .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 duct and sleeve with acoustic media, covered and mastic sealed in accordance with manufacturer's instructions.
- .3 Acceptable materials:  
BVA Systems  
Vibron

## 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.

**END OF SECTION**

**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.

**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 NON-METALLIC – INSULATED

- .1 Non-collapsible, coated aluminum foil mylar type mechanically bonded to, and helically supported by, external steel wire 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:  
Flexmaster FAB 3T  
Ductmate

## 2.3 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:  
Flexmaster T/L - VT  
Ductmate

## 3 Execution

### 3.1 DUCT INSTALLATION

- .1 Install in accordance with: SMACNA.
- .2 Maximum length of flexible duct: 1.8 m (6' 0").
- .3 Provide support at centre of flexible duct with 25 mm (1") wide galvanized hanger.

**END OF SECTION**

**1 General**

**1.1 REFERENCES**

- .1 AMCA 99-[1986], Standards Handbook.
- .2 ANSI/AMCA 210-[1985], Laboratory Methods of Testing Fans for Rating.
- .3 AMCA 300-[1985 Revised 1987], Reverberant Room Method for Sound Testing of Fans.
- .4 AMCA 301-[1990], Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .5 ANSI/ASHRAE 51-[1985], Laboratory Methods of Testing Fans for Rating.
- .6 CGSB 1-GP-181M-[77], Coating, Zinc Rich, Organic, Ready Mixed.

**1.2 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with general requirements.
- .2 Provide fan curves and sound rating data, showing point of operation, bhp W and efficiency.
- .3 Indicate following: motors, wheels, bearings, shafts.

**1.3 OPERATION AND MAINTENANCE DATA**

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

**1.4 MANUFACTURED ITEMS**

- .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 in force.

## 2 Products

### 2.1 FANS GENERAL

- .1 Capacity: flow rate, total static pressure, bhp W, revolutions per minute, power, model, size, sound power data and as indicated on schedule.
- .2 Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.
- .3 Sound ratings: comply with AMCA (Air Moving and Conditioning Association) 301, tested to AMCA 300. Unit shall bear AMCA certified sound rating seal.
- .4 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210, and ANSI/ASHRAE 51. Unit shall bear AMCA certified rating seal, except for propeller fans smaller than 300 mm (12") diameter.
- .5 Motors:
  - .1 Sizes as indicated.
- .6 Accessories and hardware: matched sets of V-belt drives, adjustable slide rail motor bases, belt guards, coupling guards, fan inlet outlet safety screens, inlet outlet dampers and vanes and as indicated.
- .7 Factory primed before assembly in colour standard to manufacturer.
- .8 Scroll casing drains: as indicated.
- .9 Finish on fume hood exhaust fans as indicated
- .10 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .11 Vibration isolation: to Section 15072 - Vibration Isolation.
- .12 Flexible connections: to Section 15820 - Duct Accessories.

### 2.2 PROPELLER FANS

- .1 Fabricate multibladed propellers of aluminum of airfoil shape within bell mouth entrance on integral mounts, with grease lubricated ball bearings, with extended lubrication fittings, suited for operating in any position, direct or [belt] driven, complete with motor as indicated.
- .2 Provide blade guards, bird screen and automatic back draft dampers on discharge, with gasketed edges.

- .3 Acceptable materials:  
Greenheck  
Penn  
Carnes  
Bailey  
Cook  
Carnes

### **2.3 MUA-1 MAKE UP AIR UNIT**

- .1 Casing cabinet hung in factory fabricated casing complete with vibration isolators and, motor, electric resistance heater, electronic temperature sensor, speed controller, and washable filter.
- .2 Capacity: As indicated.
- .3 BAS Contractor will enable/visible FB operator and interlock to exhaust fan (EF-7).
- .4 Acceptable materials:  
Thermolec  
FER-12-10-208/3/60

## **3 Execution**

### **3.1 FAN INSTALLATION**

- .1 Install fans as indicated, complete with resilient mountings and flexible connections.
- .2 Provide sheaves and belts required for final air balance.
- .3 Bearings and extension tubes to be easily accessible.
- .4 Access doors and access panels to be easily accessible.

**END OF SECTION**

**PAGE INTENTIONALLY LEFT BLANK**

**1 General**

**1.1 REFERENCES**

- .1 AMCA 99-1986, Standards Handbook.
- .2 ANSI/AMCA 210-1985, Laboratory Methods of Testing Fans for Rating.
- .3 AMCA 300-1985, Revised 1987, Reverberant Room Method for Sound Testing of Fans.
- .4 AMCA 301-1990, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .5 ANSI/ASHRAE 51-1985, Laboratory Methods of Testing Fans for Rating.
- .6 ANSI/NFPA 96 – Vapour Removal from Coking Equipment.

**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.

**2 Products**

**2.1 FANS GENERAL**

- .1 Capacity: flow rate, total static pressure Pa, r/min, bhp W, 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 80,000 100,000 h in accordance with AFBMA L10 life standard. Bearings to be rated and selected in accordance with AFBMA 9 and AFBMA 11.
- .6 Acceptable materials:
  - Greenheck
  - Penn Barry
  - Cook
  - Jenn
  - Carnes
  - Acme
- .7 Provide factory mounted speed control for all direct drive motors.

## 2.2 ROOF EXHAUSTERS

- .1 Centrifugal V belt or direct driven as indicated.
  - .1 Housing: spun aluminum complete with resilient mounted motor and fan.
  - .2 Impeller: aluminum non-overloading.
  - .3 Adjustable motor sheave
  - .4 12 mm (12/25") mesh 2.0 mm (13 gauge) dia aluminum birdscreen.
  - .5 Automatic gasketed aluminum backdraft dampers.
  - .6 Disconnect switch within fan housing.
  - .7 Continuous curb gaskets, cadmium plated securing bolts and screw, and sound insulating.
- .2 Roof curbs; 450 mm high and of same manufacturer as fan and built to suit model specified.
- .3 Size and capacity: as indicated
- .4 To NFPA 96 requirements where 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.
- .7 Acceptable materials:  
Greenheck  
Nutone  
Broan

## **2.4 DRYER BOOSTER FAN**

- .1 Provide a fully automatic dryer booster fan where indicated.
- .2 Provide a Fantech DBLT or equal 100 mm (4") paintable galvanized lint trap complete with removable filter and 15 mm flange for flush mounting.
- .3 Fan shall be inline complete with low profile, self cleaning backward inclined impeller and high efficiency meter suitable for 120/1/60.
- .4 Provide a current sensing relay and turn over to Electrical Division for installation.
- .5 All wiring shall be by Electrical Division.
- .6 Acceptable material:  
Reversomatic 'TLD' Series with DAS 200 sensor.

## **3 Execution**

### **3.1 INSTALLATION**

- .1 Install in accordance with manufacturer's instructions.
- .2 Provide backdraft damper at building exterior penetration.

**END OF SECTION**

PAGE INTENTIONALLY LEFT BLANK

**1 General**

**1.1 REFERENCES**

- .1 ASTM A525M-[90], Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) 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.

**2 Products**

**2.1 VARIABLE AIR VOLUME BOXES (VAV CONTROL DAMPER)**

- .1 Single duct, variable volume air distribution assemblies of the sizes and capacities as shown on the plans.
- .2 The assemblies shall be pressure independent and shall reset to any air flow between zero and the maximum catalogued air volume.
- .3 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.).
- .4 Sound ratings of air distribution assemblies, shall not exceed 30 NC at 25 Pa (0.10" w.c.) static pressure.
- .5 Pressure shall be ARI Certified.

- .6 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.
- .7 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.
- .8 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.
- .9 Provide 900 mm (36") long discharge sound attenuator for each unit.
- .10 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 access door. Refer to schedule for reheat coil requirements. Provide minimum 2 row coil.
- .11 DDC controls including controller, flow transducer, electric actuator and protective shroud if required to be provided by controls manufacturer.
- .12 Terminal unit manufacturer shall factory mount controller and actuator including tubing from cross flow sensor to controls, wiring controller to motor and calibration.
- .13 Size and capacity: as indicated.
- .14 Acceptable materials:  
E.H. Price SDV  
Nailor  
Titus  
Kreuger  
Carnes  
Metalaire

### **3 Execution**

#### **3.1 INSTALLATION**

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.

- .3 Install access door adjacent to each damper.
- .4 Install controls as per manufacturer's requirements.
- .5 Install with at least 100 mm (4") of flexible inlet ducting.

**END OF SECTION**

PAGE INTENTIONALLY LEFT BLANK

**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 him from independent testing agency signifying adherence to codes and standards.

**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:  
E.H. Price  
Nailor  
Krueger  
Titus  
Metalaire

## 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 R2: aluminum 25 mm (1") border, single 45 deflection, horizontal face bars, at 15 mm (1/2") spacing screwed fastening, finish selected by Consultant. Model: E.H. Price 635NLA.
- .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: 4-cone adjustable, steel, square type, having adjustable pattern, baked off white finish, lay-in and or surface mounted (sliding type adjustment will not be accepted). Model: EH Price SCDA-4C.
- .3 Type D2: aluminum 600 mm x 600 mm, square type, high capacity having adjustable pattern, duct and or surface mounted, round neck adaptor, two or three way pattern, as indicated (sliding type adjustment will not be accepted). Baked off white finish. Model: EH Price SMDA-2S (3S).
- .4 Type, size, and capacity: as indicated.

## 2.4 OPEN MESH SCREEN

- .1 15 mm x 15 mm (1/2" x 1/2") open mesh screen fastened on 25 mm (1") border, screw fasten.
- .2 On all open ends of ductwork and where indicated.

- .3 Size: To match ductwork size.

### **3 Execution**

#### **3.1 INSTALLATION**

- .1 Install in accordance with manufacturers 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**

PAGE INTENTIONALLY LEFT BLANK

**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.

**2 Products**

**2.1 FIXED LOUVRES – ALUMINUM (FLANGE FRAME)**

- .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 panel length of 1800 mm (72").
- .4 Perimeter flange frame, head, sill and jamb: 50 mm (2") 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") mesh, 2 mm (5/64") diam wire aluminum birdscreen on inside face of louvres in formed U-frame.
- .7 Finish: Kynar 500  
Colour: to Consultant's approval.
- .8 Acceptable materials:  
Ventex  
Greenheck  
Construction Specialties  
Airlite Co.  
Krueger  
Ruskin  
Ventmaster  
Nailor

## 2.2 THIN LINE 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 Perimeter flange frame, head, sill and jamb: 50 mm (2") 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: 20 mm (3/4"), 2 mm (5/64") diam wire aluminum birdscreen on inside face of louvres in formed U-frame.
- .7 Finish: Kynar 500  
Colour: to Consultant's approval.
- .8 Acceptable materials:  
Greenheck ESJ-150  
Construction Specialties  
Airlite Co.  
Krueger  
Ruskin  
Ventmaster  
Ventex

**3 Execution**

**3.1 INSTALLATION**

- .1 Turn over to General Contractor for installation. Installation shall be 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.
- .5 Provide all louvres not supplied by General Contractor.

**END OF SECTION**

PAGE INTENTIONALLY LEFT BLANK

**1 General**

**1.1 REFERENCES**

- .1 ANSI/NFPA 96-[1991], Removal from Cooking Equipment.

**1.2 SHOP DRAWINGS AND PRODUCT DATA**

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

**1.3 MAINTENANCE DATA**

- .1 Provide 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 by him from independent testing agency signifying adherence to codes and standards.

**2 Products**

**2.1 BOX CANOPY FILTER HOOD**

- .1 General Description:  
.1 1065 mm (42") x 900 mm (36") filter hood shall be suitable for all cooking equipment.  
.2 The hood shall be ceiling hung with a recommended mounting height of 1981 mm (6' - 6") from the finished floor. The hood shall be finished in a No. 4 stainless steel finish on all exposed sides.
- .2 Efficiency:  
.1 The hood shall be equipped with high efficiency UL/ULC listed baffle grease filters. The exhaust air shall accelerate through multiple turns within the baffle filter.  
.2 The liquefied grease shall drain down the baffles, along the grease trough, and into a grease cup.
- .3 Spring Air Systems FD-B Hood  
.1 The filter hood shall be box canopy, high efficiency, filter hood, UL/ULC listed, and built in accordance with the NFPA-96. The unit casing shall be a minimum 18 ga. stainless steel on all exposed surfaces.

- .2 The filter hood shall include UL/ULC listed baffle grease filters mounted in an integral stainless steel rack inclined at 45 degrees.
- .3 The filter rack shall include a full length stainless steel grease gutter and grease cup.
- .4 The fire damper shall be an arrangement "D", butterfly type, constructed of stainless steel with metal blade and edge seals. The fire damper shall be activated by a fusible link and dead weight arrangement.
- .5 The hood shall have two (2) incandescent lights evenly spaced along the length of the hood.
- .6 Accessories:
  - .1 Stainless steel No. 4 finish fascia panel.
  - .2 Spacer from wall.

## 2.2 FIRE SUPPRESSION SYSTEM

- .1 Fire detection and suppression system: ULC listed and labeled, wet chemical pre-engineered fixed nozzle type for appliances, filters and ductwork.
- .2 Manual and automatic dump system. Automatic actuation shall be provided by an appropriate number of fuse link detectors mounted in series on a stainless steel wire input line to the control head. Manual actuation shall be provided by turning a handle on the primary head and/or by an optional remote pull station with a dedicated stainless steel input line to the control head.
- .4 Cable and conduit system.
- .5 Bottle capacity to meet demand. Submit sizing with shop drawings.
- .6 The cartridge shall be an integral part of the control head assembly. The wet chemical storage cylinder shall be D.O.T.-rated for stored pressure of 225 psig, and a pressure gauge shall be provided on the cylinder valve for visual inspection.
- .7 Nozzles in exhaust duct, hood plenum, and appliance protection.
- .8 Provide professional engineered drawings (stamped) and field review when requested by the local authority having jurisdiction.
- .9 Acceptable materials:
  - Spring Air
  - Garland
  - Pyro-Chem
  - Halton

**3 Execution**

**3.1 INSTALLATION**

- .1 Install hoods and suppression system supplied by the kitchen equipment supplier in accordance with manufacturer's instructions.
- .2 Install hoods in accordance with NFPA 96 standards.
- .3 Test hoods suppression system and exhaust fans as specified.

**3.2 EXHAUST HOOD SYSTEM TESTING**

- .1 Test exhaust hood and ductwork system in accordance with and in the presence of the local authority requirements. Provide written documentation and verification of acceptance.
- .2 Provide all equipment to provide testing of system.

**3.3 FIRE SUPPRESSION SYSTEM TESTING**

- .1 Dump test system to requirements and in the presence of local authorities having jurisdiction.
- .2 After completion of test recharge system and make operable for owners' use.

**END OF SECTION**

**PAGE INTENTIONALLY LEFT BLANK**

**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.

**2 Products**

**2.1 BREECHINGS**

- .1 Shop fabricated 3.5 mm (16 gauge) thick, galvanized steel, with sweep bends from boiler outlet to thimble or chimney as indicated.
- .2 Cleanouts with bolted gaskets covers at end of mains and change in directions.

## **2.2 'A' VENT PRESSURE CHIMNEY**

- .1 ULC labelled, 760°C (1400°F) rated, all fuels.
- .2 Sectional, prefabricated, double wall with 25 mm (1") mineral wool insulation with mated fittings and couplings.
  - .1 Liner: 316 stainless steel.
  - .2 Shell: stainless steel.
  - .3 Outer seals between sections: to suit application.
  - .4 Inner seals between sections: to suit application.
- .3 Acceptable Manufacturers:
  - .1 Pro Tech Systems, Inc. – FasNSeal W2 (Insulated)
  - .2 Van Packer
  - .3 X-Flex Model SVE-IV (Insulated)

## **2.3 ACCESSORIES**

- .1 Cleanouts: bolted, gasketed type, full size of breeching, as indicated.
- .2 Hangers and supports: in accordance with recommendations of Sheet Metal and Air Conditioning Contractors National Association Inc. (SMACNA).
- .3 Rain cap.
- .4 Expansion sleeves with heat resistant caulking, held in place as indicated.
- .5 600 mm (24") high roof flashing cones.
- .6 Supports and anchors.

## **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. Pack annular space with heat resistant caulking.
- .5 Install flashings on chimneys penetrating roofs, as indicated.
- .6 Install rain caps and cleanouts, as indicated.

**END OF SECTION**

**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.

**1.2 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with general requirements.
- .2 Indicate the following:
  - .1 General arrangement showing terminal points, instrumentation test connections.
  - .2 Clearances for operation, maintenance, servicing, cleaning.
  - .3 Piping hook-ups.
  - .4 Equipment electrical drawings.
  - .5 Burners and controls.
  - .6 All miscellaneous equipment.
  - .7 Flame safety control system.
  - .8 Breeching and stack configuration.
  - .9 Stack emission continuous monitoring system to measure CO, O<sub>2</sub>, NO<sub>x</sub>, SO<sub>2</sub>, and stack temperature.
- .3 Engineering data to include:
  - .1 Boiler efficiency at 100%, of design capacity.
  - .2 Radiant heat loss at 100% design capacity.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Submit operation and maintenance data for incorporation into manual specified in general requirements.

## 1.4 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.

## 2 Products

### 2.1 BOILERS

- .1 Provide two (2) Viessmann Vitodens model 200-W B2HA 150 530 MBH input, 330 MBH output gas fired stainless steel boilers where indicated on drawings complete with modulating gas burner. Gas burner to be suitable for 120/1/60.
- .2 Modulating matrix-compact gas burner with extremely low emissions: Nox: 8.9 ppm (air-free), co: 5.5ppm (air-free). A.F.U.E. of up to 94.2%.
- .3 Compact inox-radial heat exchanger surface made of high-alloy stainless steel designed on the laminar heat transfer principle for high operational reliability and a long service life:
  - the radial design of the high-alloy heat exchanger allows maximum performance within a small space.
  - the defined gaps between coils produce a laminar, high-intensity, efficient heat transfer.
  - rectangular design of coils maximizes the coil gap length and ensures maximum utilization of heat exchanger surface.
- .4 Combi series with integrated stainless steel plate heat exchanger for instantaneous dhw production.
- .5 Self-calibrating flue gas adaptation to the flue gas pressure drop under varying operation conditions.

- .6 Provide for each boiler and to meet ANSI/ASME requirements the following:
  - relief valves: ANSI/ASME rated, set at 210 kpa (50 psig) minimum and to release entire boiler capacity.
  - pressure gauge: 90 mm diameter complete with shut-off cock.
  - thermometer: 115 mm diameter range 10 to 150c.
  - low water cut-off: with visual and audible alarms.
  - isolating valve: on supply and return connections.
  - drain valve: NPS 1½.
  - hand/off/auto selector switch
- .7 Install to manufacturer's recommendations and requirements and ANSI/ASME boiler and pressure vessel code section iv.

## **2.2 BOILER SYSTEM CONTROL**

- .1 Provide all necessary relays and components for a complete operational system in conjunction with the BAS contractor as specified in Section 15921.
- .2 Provide all necessary flow switches, differential switches and temperature sensors for installation in the HWS/HWR mains by the piping contractor.

## **2.3 BOILER TRIM & ACCESSORIES**

- .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 controller to control the sequential operation of the burner.
  - .6 Separate inlet and outlet water temperature sensors capable of monitoring flow.
  - .7 Exhaust temperature sensor.
  - .8 Fully modulating gas valve.
  - .9 Selector switch with pilot lights.
  - .10 Low loss header supplied by boiler manufacturer.

## **2.4 NEUTRALIZING TANK**

- .1 Rotationally molded low-density polyethylene sump. Capacity: 7 gal, 15" diameter x 15" tall, 2" inlet.
- .2 15 mm (1/2") extruded high-density polyethylene top and inspection ports complete with neoprene or epdm gasket to suit. Provide 3/32 steel top and extension for in floor installation.

- .3 Series 60 high-density polyethylene fittings.
- .4 Provide initial charge of limestone and store one (1) additional charge where directed on site.
- .5 Provide 110V model 47R ph monitor complete with alarm, ph electrode and co-axial cable. Install to manufacturers recommendations.
- .6 Acceptable material: SMS model AN-4.

## **2.5 BOILER 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.
  - .5 LED Display Panel to adjust set points and control operating parameters. LED 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.

## **2.6 ACCEPTABLE MATERIALS**

- .1 Viessmann Manufacturing Company.
- .2 No alternates.

## **3 Execution**

### **3.1 FACTORY TESTING - HYDROSTATIC**

- .1 Each factory "packaged" boiler shall be hydrostatically tested and bear the ASME "H" stamp.

### **3.2 FACTORY TESTING – FIRE TESTING**

- .1 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.

### **3.3 FIELD TESTING**

- .1 The boiler manufacturer shall field test the following:
  - .1 Boiler and burner interlocks.
  - .2 Actuators.
  - .3 Valves.
  - .4 Controllers.
  - .5 Gauges.
  - .6 Thermometers.
  - .7 Pilot lights.
  - .8 Switches.
  - .9 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 WARRANTIES**

- .1 The boiler manufacturer shall warrant each boiler, including boiler, trim, boiler control system, and all related components, accessories, and appurtenances against defects in workmanship and material for a period of eighteen (18) months from date of shipment, or twelve (12) months from date of start-up, whichever occurs first. Heat exchanger and fuel burner shall be warranted for a period of five (5) years from date of shipment.

### **3.6 TSSA INSPECTION**

- .1 This contractor shall make application, arrange, and pay for a TSSA inspection of the boiler plant and associated equipment installed under the contract at the completion of the project and prior to final acceptance of the system.
- .2 Provide a copy of the TSSA report in the maintenance manuals.

**END OF SECTION**

**PAGE INTENTIONALLY LEFT BLANK**

**1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ASHRAE 84, Method of Testing Air-to-Air Heat/Energy Exchangers.

**1.2 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with general requirements.
- .2 Indicate following: performance.

**1.3 OPERATION AND MAINTENANCE DATA**

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

**1.4 MAINTENANCE MATERIALS**

- .1 Provide maintenance materials in accordance with general requirements.
- .2 Furnish list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.

**1.5 MANUFACTURED ITEMS**

- 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.

**2 Products**

**2.1 GENERAL**

- .1 Comply with ASHRAE.

## 2.2 HEAT WHEEL AIR TO AIR ENERGY RECOVERY VENTILATOR

### .1 General

.1 Packaged, energy recovery ventilator(s) (outdoor or indoor as shown in equipment schedule) consisting of enthalpy wheel, wheel drive system, ventilation air fan, exhaust air fan, necessary dampers, temperature sensors, and microprocessor controls.

### .2 Unit Cabinet

.1 Cabinet shall be constructed of 20 gauge G-90 galvanized steel with 12 gauge galvanized frame.

.2 Outdoor units to have series 8,000 exterior pre-paint surface consisting of baked-on polyester paint on G-90 base metal. Metal finish shall withstand a minimum of 10 years of exterior exposure without cracking, chipping, peeling, brazing, or spotting. Outdoor units shall have no screw penetrations on the roof and shall be airtight and waterproof.

.3 Outdoor units shall have lifting holes at unit base for rigging onto rooftop.

### .3 Access

.1 Access to all components that require servicing shall be provided through sealed and easily removable access panel(s).

.2 Enthalpy wheel shall be easily removable from the unit.

### .4 Enthalpy Wheel

.1 Enthalpy wheel substrate should be of pure aluminum foil to allow quick and efficient uptake of thermal energy and provide sufficient mass for optimum heat transfer allowing maximum sensible heat recovery at low rotational speeds.

.2 The weight of the desiccant coating and the mass of the aluminum shall be in a ratio to allow equal recovery of sensible and latent heat. The desiccant will have sufficient mass and be coated with a non-masking porous binder adhesive on the aluminum to allow quick uptake and release of water vapor. Impregnated desiccants in non-metallic substrates such as paper, plastic, synthetic or glass fiber will not be acceptable.

.3 Energy recovery effectiveness values shall be tested in accordance with ASHRAE 84 and ARI Standard 1060.

.4 Manufacturer shall provide verification (in writing) confirming that the internal pore diameter distribution inherent in the desiccant limits adsorption to materials no larger than the critical diameter of a water molecule (4.0 Angstrom).

.5 Energy recovery wheel shall be constructed of aluminum and must comply with NFPA-90A for flame spread and smoke generation.

.6 Enthalpy wheel drive belt shall be designed so that there is no need for a take-up pulley and no field adjustments required (0% stretch after initial tension).

.7 Enthalpy wheel cassette shall be complete with face seal and perimeter seal to prevent cross leakage between the two airstreams. Both seals shall be contact seals (non-wearable) to prevent leakage from occurring at the seal.

.8 Enthalpy wheel shall come complete with an adjustable purge section to eliminate carry over of exhaust air stream contaminates from wheel rotation.

.9 Enthalpy wheel shall be self cleaned by two counter flow airstreams.

.10 Enthalpy wheel shall be installed in removable cassette to allow for inspection, removal and cleaning.

- 
- .5 Operating Characteristics
    - .1 Unit shall be capable of providing a constant volume of air at a specified external static pressure at all fan operating speeds.
  
  - .6 Blowers
    - .1 Fan ratings are based on tests made in accordance with AMCA Standard 210.
    - .2 Blowers must be selected to operate on a stable efficient part of the fan curve when delivering air quantities scheduled against static of the system.
    - .3 Fan blades shall be statically and dynamically balanced and tested prior to shipment.
    - .4 Fan shall be provided with internal vibration isolation mounts.
    - .5 Fan discharge shall be as noted on the plans.
  
  - .7 Motors
    - .1 Motors shall be continuous duty, permanently lubricated, and matched to the fan loads.
    - .2 Motors shall meet new EPAC regulations for efficiency and shall have inverter spike resistance wire for protection.
  
  - .8 Electrical Requirements
    - .1 Unit shall have single point power connection only.
    - .2 All controls shall be factory mounted and wired, requiring only field installation of remote sensing devices and wiring to unit mounted terminal strips.
    - .3 Unit shall have 24 VAC (30VA) for field installed sensing devices, etc.
  
  - .9 Filtration
    - .1 Unit must come equipped with standard size medium efficiency filtration (30% DSE.)
  
  - .10 Controls
    - .1 Unit shall be provided with a factory mounted and factory wired microprocessor control.
    - .2 All service connectors shall be quick disconnect type.
    - .3 Unit circuitry shall allow the follow operational characteristics:
      - .1 dry contacts for occupancy control
      - .2 remote fan interlock on call for ventilation
      - .3 selection of low or high speeds
      - .4 remote wall contacts
      - .5 free cooling enthalpy contacts to stop wheel rotation
      - .6 24 VAC contacts (30VA) for external components
  
  - .11 Optional Accessories
    - .1 Defrost Damper/Recirculation Defrost Cycle:
      - .1 If the outdoor ambient drops below 5°F (-15°C) the defrost damper closes off outdoor air, exhaust fan runs, and the supply air fan shuts off. Setpoint based on 40% return air relative humidity.
      - .2 Damper defrost may be used with ventilation air temperatures down to -21°F (-30°C).

- 
- .2 Hoods (for roof mounted units only)
    - .1 Unit shall include intake and exhaust hoods with birdscreen.
    - .2 Maximum design velocity on intake hood must not exceed 200 ft/min.
    - .3 Hoods to include dampers with spring return, two way driven actuators, and/or and exhaust backdraft damper.
  - .3 Double Wall Construction
    - .1 Cabinet shall be insulated throughout and lined with a 26 ga. galvanized wall to eliminate potential puncture of insulation membrane.
  - .4 Disconnect Switch
    - .1 Unit shall include fused or non-fused disconnect switch.
  - .5 Access Panels
    - .1 Unit shall have deluxe door access for filters and blower doors consisting of ¼ turn fasteners and polymide handles.
  - .6 Wheel Rotation Sensor
    - .1 Sensor device and contacts shall be included to provide a low voltage signal when wheel rotation stops longer than the sensor set point.
  - .7 Enthalpy Wheel Purge Section
    - .1 Enthalpy wheel cassette shall include a purge section which is field adjustable from 7.5 to 12.5 rpm.
  - .8 Night Set Back
    - .1 24 hour programmable timer shall be included for occupied/unoccupied time settings.
  - .9 CO2 Controller
    - .1 Non-dispersed infra-red control shall be provided to trigger ventilation at levels above 1000 ppm of CO2.
  - .10 Wall Controls
    - .1 Remote wall control shall be provided by the manufacturer.
  - .11 Roof curb
    - .1 Roof curb shall be constructed of galvanized steel.
    - .2 Roof curb shall be knock down type complete with instructions for field assembly matched to unit specifications.
  - .12 Free Cooling Enthalpy Control
    - .1 Free cooling enthalpy control shall be provided to stop wheel when applicable on calls for cooling.
  - .12 Acceptable Manufacturers
    - .1 Penn Barry
    - .2 Greenheck
    - .3 Ruskin
    - .4 Cook
    - .5 Aldes

**3 Execution**

**3.1 INSTALLATION**

- .1 Install in accordance with manufacturers recommendations.
- .2 Support independently of adjacent ductwork with flexible connections.
- .3 Install access doors in accordance with Sections for access to coils and dampers.

**END OF SECTION**

PAGE INTENTIONALLY LEFT BLANK

**1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 CAN/CGSB 1.181, Ready Mixed Organic Zinc, Rich Coating.
- .3 ANSI/NFPA-90A, Installation of Air Conditioning and Ventilating Systems.

**1.2 SHOP DRAWINGS AND PRODUCT DATA**

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

**1.3 MAINTENANCE DATA**

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

**1.4 MAINTENANCE MATERIALS**

- .1 Provide maintenance materials in accordance with general requirements.

**1.5 UNIT ASSEMBLY**

- .1 Unless stated otherwise, air handling units are to be shipped to the job in one piece, factory assembled. All equipment shall be factory tested prior to shipment.
- .2 The heat exchanger shall be manufacturer by the air handling manufacturer as an integrated package.

**1.6 MANUFACTURED ITEMS**

- .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 in force.
- .2 The air handling units and major components shall be products of manufacturers regularly engaged in the production of such equipment and with a minimum of fifteen continuous years of proven production experience.
- .3 Manufacturer shall have a fully implemented and auditable quality assurance program, equal to the ISO-9002 Quality Standard.

## 2 Products

### 2.1 GENERAL

- .1 Field Factory assembled components to form units supplying air at design conditions as indicated and specified.

Acceptable materials:

Engineered Air

Haakon

Temprite Industries

### 2.2 INTERNAL WIRING

- .1 All fans shall be internally wired for single point connection for connection to remote frequency drives and starters.

- .2 Provide dead front not fused disconnect.

#### .3 SAFETIES

.1 The manufacturer shall supply and install safety controls. Safety control transmitters shall be located at the sensor and output (0-10 V-DC) shall terminate on a numbered terminal strip in the main electrical panel.

.2 The manufacturer shall provide the following safety controls:

.1 Low limit protection thermostat (mixed air plenum).

.2 Differential pressure switch - one differential pressure switch for each bank of filters.

.3 The output of the safety sensors and devices shall be available for connection to the school BAS.

#### .4 Electrical

.1 Air handling units shall be factory wired and tested. All electrical circuits shall undergo a dielectric strength test, and shall be factory tested and checked as to proper function.

.2 Pre-wired units shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electrical Code, Part 2.

.3 Provide all necessary terminal blocks, motor contactors, motor overload protection, grounding lugs, and terminals for the connection of external control devices or relays.

#### .5 CONTROLS

.1 All control sensors and devices shall be wired to a numbered terminal strip in the main panel, ready to be connected to the building BAS.

.2 The manufacturer shall supply and install 10k ohm NTC Type 3 temperature platinum temperature sensors. The sensors shall be located where they will register accurate measurement of the monitored value. The mixed air sensor shall be of the averaging type. The return air and outdoor air shall be single point duct mount type. Temperature transmitter shall be located at the sensor and output (0-10 VDC) shall terminate on a numbered terminal strip in the main panel.

- .3 Single-point duct temperature sensors:
  - .1 Not required from manufacturer - shall be installed by controls subcontractor.
- .4 Averaging type duct sensors
  - .1 Constructed of FT6 plenum rated cable incorporating a minimum of 9 temperature sensors encapsulated at equal distances along the 24 foot length of the element. The assembly acts as a single sensor reporting the average temperature from all individual sensors.
  - .2 end-to-end accuracy +/- 0.3 °C.
  - .3 Mount in a zigzag manner to provide continuous coverage of the entire duct cross-sectional area.
  - .4 The use of thermistor type sensors is acceptable.
  - .5 The manufacturer shall provide temperature sensors in the following locations:
    - .1 Mixed air plenum

**2.3 UNIT CONSTRUCTION**

- .1 Unit casing shall be of minimum 1.6mm (16 gauge) satin coat galvanized sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two part acid based etching primer. Finish coat shall be an electrostatically applied enamel, to all exposed surfaces. All unprotected metal and welds shall be factory coated.
- .2 All high pressure 125 mm (5") 1250Pa to 225 mm (9") 2250Pa w.c. fan sections shall be constructed of 2 mm (14 gauge) metal. Continuous high pressure sealant shall be provided between all panels.
- .3 All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water resistant sealant.
- .4 The following components shall be provided with a 0.85 mm (22 gauge) solid, or 0.70 mm (24 gauge) 40% free area perforated galvanized metal liner over insulated areas:

	Solid Liner	Perf. Liner
Fan Sections	_____	<u>  X  </u>
Coil Sections	<u>  X  </u>	_____
Filter Sections	<u>  X  </u>	_____
Mixing Sections	<u>  X  </u>	_____
Access Sections	<u>  X  </u>	_____
Return plenums	_____	<u>  X  </u>

- .5 Units shall be provided with gasketed access doors to the following components: fans and motors; filters; dampers and operators; and access plenums. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable .
- .6 Casings shall be supported on formed galvanized steel channel or structural channel supports, designed and welded for low deflection. Integral lifting lugs shall be provided for hoisting

- .7 All units shall be internally insulated with 50 mm (2") thick 24 kg./m<sup>3</sup> (1 5lb./ft<sup>3</sup>) density, neoprene coated fibre glass thermal insulation.
- 24 kg/m<sup>3</sup> (1 5 lb/ft<sup>3</sup>) insulation shall be secured to metal panels with a fire retardant adhesive and welded steel pins at 400 mm (16") o/c. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent erosion of exposed edges. Drain pans and all floor areas shall be insulated on the underside.
- .8 Unit casing floors in walk in sections shall be fabricated with 2.0 mm 14 gauge galvanized checker plate steel. Provide reinforcing channels under floor to minimize deflection.
- .9 Cooling unit drain pans shall be an integral part of the floor panelling, a minimum of 50mm (2") deep, with welded corners. Drain pans shall extend a minimum of 300 mm (6") downstream of coil face and be provided with a 25 mm (1") M.P.T. drain connection. Drain pans must be sloped and pitched such that there is no standing water. Intermediate drain pans shall be provided between cooling coils above 1650mm (65"). Extend drain under complete fan section where fan is downstream of humidifier. Drain pans shall be stainless steel.
- .10 Air handling unit shall be weatherproofed and equipped for installation outdoors. This shall include generally for the prevention of infiltration of rain and snow into the unit, and: louvres or hoods on air intakes and exhaust openings with 25 mm (1") (galvanized inlet screens; rain gutters over all access doors; all joints caulked with a water resistant sealant; roof joints turned up 50 mm (2") with three break interlocking design; outer wall panels extend a minimum of 6 mm (1/4") below the floor panel; drain trap(s) for field installation.
- .11 Units shall be provided with gasketed access doors to the following components: fans and motors; filters; dampers and operators; access plenums and access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.
- .12 Provide hinged access doors, fully lined, with zinc plated piano hinges and brass pins, with a minimum of two camlock fasteners for all units over 1200 mm (48") high.
- Provide hinged access doors, fully lined, with zinc plated piano hinges and brass pins, Ventlock 310 handles, operable from both sides for all units over 1200 mm (48") high. Whenever possible, hinged access doors to areas of negative pressure shall open out, and to areas of positive pressure shall open in. Where space constrictions require the use of outward opening doors to an area of positive pressure, a clear warning label must be affixed.
- Hinged access doors shall be provided with tie back clips.
- .13 Provide full perimeter roof mounting curb of heavy gauge sheet metal, minimum of 600 mm (24") high, and complete with wood nailer, neoprene sealing strip, and fully welded "Z" bar with 25 mm (1") upturn on inner perimeter, to provide a complete seal against the elements. Provide on the interior of the roof curb 100 mm (4") thick rigid foil faced insulation over entire surface. Foil tape all joints including joints at curb. External insulation of the roof mounting curb shall be provided by the Roofing Subcontractor.

## 2.4 FANS

- .1 Centrifugal fans shall be rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be selected for stable operation at least 20% below the first critical RPM. Fan shafts shall be provided with a rust inhibiting coating.
- .2 Drives shall be adjustable on fans with motors 3.73 kW (5 hp) or smaller. On fans with larger motors, fixed drives shall be provided. All drives shall be provided with a rust inhibiting coating. The air balancer shall provide for drive changes (if required) during the air balance procedure.
- .3 Motor, fan bearings and drive assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly, where required. Motor mounting shall be adjustable to allow for variations in belt tension.
- .4 Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor which is welded to the structural frame of the unit. The isolators shall be neoprene-in-shear type for single 230mm (9") to 380mm (15") forward curve fans. All other fans shall incorporate vertical spring type isolators with levelling bolts, bridge bearing waffled pads with minimum 25 mm (1") static deflection designed to achieve high isolation efficiency. Fans shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric, with a sealed double locking fabric to metal connection.
- .5 Provide extended grease lines terminating outside the serviceable side of the unit.
- .6 Provide fan scroll access doors and drains.
- .7 Fan motors shall be ODP high efficiency suitable for remote VFD's.

## 2.5 COILS

- .1 Coils shall be Ultrafin and/or Superfin as manufactured by Engineered Air, constructed of copper tube, aluminium fin, copper headers with schedule 40 steel pipe connectors, male N.P.T. Fins constructed of aluminium shall be rippled for maximum heat transfer and shall be mechanically bonded to the tubes by mechanical expansion of the tubes. The coils shall have a galvanized steel casing. All coils shall be factory tested with air at 2070 kPa (300 psig) while immersed in an illuminated water tank.
- .2 Headers shall be outside the air handling unit for maximum serviceability. The non-headered end of the coil shall be fully concealed. Provide auxiliary drain pan complete with 13 mm (1/2") MPT drain connection at headered end of cooling coils.
- .3 Provide an insulated header cover to conceal exposed headers.
- .4 Coils shall be removable from the unit at the header end, unless shown otherwise on the drawings.

- .5 Refrigerant Superfin evaporator type coils shall be equipped with distributors connected to the coil by copper tubes. Where a hot gas bypass is required, the inlet shall be at the refrigerant distributor. Solenoid valves, expansion valves, and related accessories are to be provided and installed by the refrigeration contractor.
- .6 Refrigerant coils with multiple compressors shall be alternate tube circuited in order to distribute the cooling effect over the entire coil face at reduced load conditions. Provision for use of thermal expansion valves must be included for variable air volume and/or make-up air applications.

## 2.6 GAS HEAT SECTION (DJS) INDIRECT FIRED

- .1 General
  - .1 Heating units shall have an indirect natural gas fired heating section that is ETL, C-ETL, approved for both sea level and high altitude areas. The entire assembly shall be approved and labelled by a nationally recognized certification agency.
  - .2 Operating natural gas pressure at unit(s) manifold shall be 1750 Pa (7" w.c.)
  - .3 Gas fired units shall be approved for operation in -40°C/-40°F locations.
- .2 Heat Exchanger
  - .1 Heat exchanger shall be a primary drum and multi-tube secondary assembly constructed of titanium stainless steel with multi-plane metal tubulators, and shall be of a floating stress relieved design. Heat exchanger shall be provided with condensate drain connection. The heat exchanger casing shall have 25 mm (1") of insulation between the outer cabinet and inner liner. Blower assemblies close coupled to duct furnace type heat exchangers are not acceptable.
  - .2 Units shall be tested and certified to ANSI standards to provide a minimum of 80% efficiency throughout the entire operating range as required by ASHRAE 90.1. The manufacturer shall be routinely engaged in the manufacture of this type of high efficiency equipment.
  - .3 The burner assembly shall be a blow through positive pressure type with a combustion air damper interlocked with main gas valve to provide optimum air/fuel ratios at all inputs with 80% or higher efficiency throughout its operating range. Flame surveillance shall be with a solid state programmed flame relay utilizing a flame rod for gas operation. The burner and gas train shall be in a cabinet enclosure. Insulation in the burner section shall be a heat reflective galvanized steel liner. Burners to be manufacturer by Maxon, Ovenpak or Engineered Air. Atmospheric burners or burners requiring power assisted venting are not acceptable.
  - .4 Modulating burners shall have a 15:1 turndown providing that the minimum input is at least 100 MJ.
  - .5 Controls: An integral control panel shall be completely pre-wired with motor contactors, overloads, control transformer, high limit, combustion air flow switch, terminal block and all necessary relays. The control of the unit shall be provided with electronic control using modulating discharge air sensor by Controls Division.
  - .6 Provide warm weather bypass control for all units utilizing modulating discharge air controls, to allow the supply fan to continue operating during the purge cycle whenever ambient temperature is above the burner ambient set point.

- .7 All operating controls and functions shall be factory tested prior to shipment.
- .8 Operating natural gas pressure shall be 7" (1750 Pa) W.C.
- .9 Controls
  - .1 Integrated controls with discharge air sensor. Discharge air sensor shipped loose for mounting in ductwork downstream.
  - .2 Accessory remote controls or building automation system for reset based on 0-10VDC or 4-20 ma signal.
  - .3 Mount discharge air controller where indicated on plans or 20' downstream in ductwork. Wire back to unit EMT conduit to the standards of Electrical Division.
- .10 Electrical:
  - .1 All units to be completely pre-wired including motor starter and overloads. The connection of electrical power supply and all field wiring shall make the unit completely functional.
  - .2 Provide control transformer sized and wired to handle the electrical power requirements of the control system.
  - .3 Provide a unit mounted fused weatherproof disconnect switch sized and wired to handle switching of electrical power to the entire unit.
- .11 Pre-wired equipment and factory installed controls.
  - .1 Air handling units to be factory wired and tested, and to be certified by a recognized approval agency: C.S.A.; C.E.T.L.
  - .2 Wiring to be in accordance with latest edition of the Canadian Electrical Code, Part 1, and pertinent sections of the Part 2 of the Code pertaining to specific equipment type and purpose. All wiring to be on interior of unit.
  - .3 All electrical circuits conduit to undergo a di-electrical strength test (C.S.A. C22.2-0), and to be factory tested and checked as to proper function.
  - .4 Pre-wired air handling units to bear an approved bilingual label with all the necessary identification marks, electrical data, and any necessary cautions as required by the C.E.C. Part 2.

## 2.7 FILTERS

- .1 Filter sections shall be provided with adequately sized access doors to allow easy removal of filters. Filter removal shall be from one side as noted on the drawings.
- .2 For units with filter banks 1825 mm (72") high or less, the filter modules shall be designed to slide out of the unit. Side removal filters shall slide into a formed metal track, sealing against metal spacers at each end of the track.
- .4 50 mm (2") Pleated Panel Disposable Filters (Merv-10): Non-woven re-inforced cotton/poly fabric media with a metal support grid and heavy-duty beverage board enclosing frame. The filter media shall have an average efficiency of 30-35%+ on ASHRAE Standard 52.1.
- .5 Filter media shall meet U.L. Class 2 standards.

- .6 Provide filter bank with "Dwyer 2000 magnehelic" air filter gauge, complete with static pressure tips and aluminum tubing, all factory installed. Filter gauge to have a range of 0 mm to 50 mm (2") 0- 500 Pa. Where two or more filter banks are connected to a single gauge, multiple gauge kit with manual shut-off cocks in the air tubing shall be provided.
- .7 Where the filter gauges are provided on outdoor units they shall be mounted inside of a weatherproof enclosure with viewing window.

## 2.8 DAMPERS

- .1 Damper frames shall be u-shaped galvanized metal sections securely screwed or welded to the air handling unit chassis. Pivot rods of 13 mm (1/2") aluminum, shall turn in bronze bushings, fabricated from self- oiling bronze. Rods shall be secured to the blade by means of straps and set screws.
- .2 Blades shall be 1.3 mm (18 gauge) galvanized metal with two breaks on each edge and three breaks on centreline for rigidity. The pivot rod shall "nest" in the centreline break. Damper edges shall interlock. Maximum length of damper between supports shall be 1070 mm (42"). Damper linkage brackets shall be constructed of galvanized metal.
- .3 Dampers shall be:  
Low leak dampers shall include blade ends sealed with an adhesive backed foamed polyurethane gasketing. Interlocking blade edges shall include an all-weather PVC seal, fastened with a positive lock grip and pliable overlap edges on both the entering and leaving air sides. Pivot rods extend the full length of damper blades and are interlocked on the side through crank arms.
- .4 Certified low leak, dampers shall also be provided for return air dampers, exhaust (relief) air dampers.
- .5 Mixing dampers shall be parallel blade type.
- .6 Two position inlet dampers shall be parallel blade type.
- .7 Motorized relief dampers shall be opposed blade type.
- .8 Gravity relief dampers shall be single blade gasketed design.
- .9 Damper operators will be supplied by the temperature controls contractor and factory installed by the unit manufacturer.

## 2.9 REFRIGERATION

### .1 General

Compressors shall be R-410 high efficiency scroll type, complete with manual shutoff valves and vibrasorbers on suction and discharge lines, compressor spring isolators, reversible oil pump, and immersion type crankcase heater.

Condenser coils shall be copper tube type, mechanically expanded into aluminum fins. Coils shall be factory tested with air at 2070 kPa (300 psig) while immersed in an illuminated water tank.

Condenser fans shall be direct driven propeller type arranged for vertical draw through air flow. Motors shall be weather resistant type, with integral overload protection and designed for vertical shaft condenser fan applications. Fan and motor assemblies shall be mounted on a formed orifice plate for optimum efficiency with minimum noise level.

## 2.10 CONTROLS

.1 The AHU control will be by the Building Automation Contractor.

.2 Controls and gas manifolds shall be contained in a control panel that provides easy access to contained components.

.3 Provide a system of motor control, including all necessary: terminal blocks, motor contactors, motor overload protection, grounding lugs, control transformers, auxiliary contactors, and terminals for the connection of external control devices or relays.

.4 Provide electronic ignition of pilot through a spark rod and electronically programmed flame supervision controller.

.5 Automatic controls and gas manifolds to be housed in a control panel mounted on the air handling unit, on the access side, which meet the C.S.A/C.E.T.L. standard.

.6 Electronic Heating Control:

.1 Electronic control complete with solid state analyzer and discharge thermistor to maintain set point discharge air temperature and provide rapid response to small changes in discharge air temperature, incorporating modulating gas valve and proportional combustion air. Electronic heating controller to be Engineered Air DJM-3 or Nexus model NX3100 complete with display model NX550.

.2 Burner and unit control shall include the following standard features:  
- Service analyzer.  
- Linear gas and combustion airflow obtained via a built-in solid state linear algorithm.  
- 40°F minimum operating ambient temperature.  
- Four (4) air change pre-purge on units with over 400 MBH input.  
- Post purge.  
- Interrupted pilot.

- Self-check on startup to make sure air proving and discharge air sensors are operating within design tolerances.
- Controlled burner startup to make sure air proving and discharge air sensors are operating within design tolerances.
- Low fire stat.
- Controlled burner startup and shut down.
- Diagnostic lights for ease of set-up and service.
- Blower contactor that starts fan after burner pre-purge.
- Damper contact that allows fan to start after damper opens. Damper to close after fan stops and damper to close on flame failure.
- Non-recycling auto bypass low limit that has built-in sensor checking.
- Built-in sensor checking.
- Built-in alternate blower and damper functions and set back temperatures for unoccupied mode operation.

## 2.11 COMPONENTS

- .1 Incorporate the following components to provide a complete system.  
AHU units:
  - .1 Condensing section
  - .2 Return air blower with vertical inlet
  - .3 Outdoor air/relief section
  - .4 Mixing section
  - .5 Filter section
  - .6 Cooling coil section
  - .7 Supply air blower
  - .8 Heat exchange section with vertical discharge as indicated.

## 2.12 ACCESSORIES

- .1 Dead front non fused disconnect.
- .2 Internal wiring to terminal strip in Nema 1 enclosure with space for DDC controller.
- .3 600 mm (24") high roof curb.
- .4 Steel filter frames with disposable filter media.

## 2.13 CAPACITY

- .1 Provide unit capacity indicated.

## 3 Execution

### 3.1 INSTALLATION

- .1 Fabricate to provide smooth air flow through all components. Limit air leakage to 1% of rated air flow at 2.5 kPa (10" w.c.) suction pressure.

- .2 Apply sealer into all seams prior to assembly. Secure toe angles continuous along entire length of assembly.
- .3 Install to manufacturers requirements.

### **3.2 FANS**

- .1 Install flexible connections at fan outlets. Ensure metal bands of connectors are parallel and not touching when fan is running and when fan is stopped. Ensure that fan outlet and duct are aligned when fan is running.
- .2 Provide one (1) additional sheaves and belts required for final air balance.

### **3.3 DRIP PAN**

- .1 Install deep seal P trap on drain lines. Depth of water seal to be 2.5 times static pressure at this point.

### **3.4 START-UP/COMMISSIONING**

- .1 Unit manufacture shall perform start-up and commissioning.

### **3.5 SPARE PARTS**

- .1 One (1) complete set of filters (after final operating set).
- .2 One (1) set of spare belts.

### **3.6 WARRANTY**

- .1 One (1) year on parts and labour on all components.
- .2 Five (5) years on compressors
- .3 Ten (10) years on heat exchanger

**END OF SECTION**

**PAGE INTENTIONALLY LEFT BLANK**

**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.

**1.2 MAINTENANCE DATA**

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

**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, based on 88°C (190°F) average water temperature, 11°C (20°F) temperature drop and 15°C (59°F) E.A.T.

**2.3 FREE STANDING FINNED TUBE RADIATION (H-1)**

- .1 Copper-aluminum element shall be NPS 32 (1¼") nominal I.D. seamless copper with 4" x 4" (102 mm x 102 mm) aluminum fin. Fins to be stamped for rigidity and have integral collars to provide even spacing of 50 fins/foot (164 fins/m) and maximum heat transfer. Tube ends suitable for seat connecting. Heavy gauge element hangers shall be provided for mounting on the enclosure bracket and shall consist of galvanized rigid steel hanger with peg board style mounting hook and nylon roller bearing to allow for free expansion. Element hanger shall swing from mounting hole for free expansion of element. Centre on minimum 4 ft. (1.2 m).

- .2 Element: cradle type providing unrestricted longitudinal movement on enclosure brackets. Space brackets 900 mm (36") centers maximum.
- .3 Pedestal legs will mount solidly on the floor. The legs will have an adjustable bracket to accommodate floor level variation. Element hangers will mount on the vertical member of the enclosure bracket at desired height. The front panel will mount into the back panel integral joggle strip. The bottom of the panel is retained by the spring clip. Enclosure is 300 mm (12") high 18 gauge cold rolled steel with a factory baked-on white primer finish, with stamped top grille and open bottom.
- .4 Corners: Corners are one piece and cover the back panel as well as the front panel. Gently spread the corner apart and place over the enclosure. Bend tabs at bottom in front and back securing it to the enclosure.
- .5 Laps: Used where the enclosure is wall to wall. Laps are one piece and cover back panel as well as the front panel. Gently spread the lap apart and place over the enclosure. Bend tabs at bottom in front and in back securing it to the enclosure.
- .6 End caps: Complete the enclosure installation by installing end caps where required.
- .7 Dimensions for enclosures: Measure site conditions. Do not scale from drawing. Provide wall to wall installation.
- .8 Provide for noiseless expansion of all components.
- .9 Expansion compensators: Flexonics at each section.
- .10 Acceptable materials:  
Engineered Air WF 2A-FS  
Dunham Bush  
Sigma  
Sterling  
Rittling

## 2.4 FINNED TUBE RADIATION (H-2)

- .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 for valves. Finish cabinet with factory applied baked primer coat. Sloping top open 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.
- .8 Acceptable materials:  
Engineered Air WF-1A Series  
Slant Fin  
Sigma  
Sterling  
Rittling

## 2.5 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 for valves. Finish cabinet with factory applied baked primer coat. Sloping top, 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.
- .8 Acceptable materials:  
Engineered Air WF-1B Series  
Slant Fin  
Sterling  
Rittling

## 2.6 CABINET UNIT HEATERS (RECESSED IN WALL) (H-4)

- .1 Cabinet: Semi recessed installation as indicated, 1.6 mm (16 gauge) thick steel with rounded exposed corners and edges, recessing frame, removable panels, glass fiber insulation and integral supply and return air outlet, Arrangement 19.
- .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:
  - Engineered Air CUH Series
  - Slant Fin
  - Sigma
  - Dunham-Bush
  - Sterling
  - Rittling

## 2.7 CABINET UNIT HEATERS (H-5)

- .1 Cabinet: horizontal surface installation, 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 21.
- .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:
    - .1 Remote concealed thermostat by BAS contractor.
- .9 Acceptable materials:
  - Engineered Air CUH Series
  - Slant Fin
  - Sigma
  - Dunham-Bush
  - Sterling
  - Rittling

### **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 lockshield globe 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.

**END OF SECTION**

**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.

**2 Products**

**2.1 LINEAR RADIANT CEILING PANELS (H-6)**

- .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:
  - Airtex HEF-2
  - Epsilon
  - Frenger
  - SUN-EL ELF-2 Series
  - Sigma
  - Airtite
  - Rittling

## 2.2 CAPACITY

- .1 As indicated, based on 88°C (190°F) average water temperature, 11C° (20F°) temperature drop and 18.3C (65°F) E.A.T.

## 3 Execution

### 3.1 INSTALLATION

- .1 Install in gypsum board ceilings 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 ends of insulation to radiant panel with foil tape.

**END OF SECTION**

**PAGE INTENTIONALLY LEFT BLANK**

**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 RELATED SECTIONS**

- .1 Built up Air Handlers Section.
- .2 DDC Controls Section.
- .3 Electrical Division.

**1.4 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.

## 1.5 WARRANTY

- .1 The VFD shall be warranted by the manufacturer for a period of five (5) years from date of substantial completion. 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.

## 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 3<sup>rd</sup> 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 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 I<sup>2</sup>t 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.

## **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 (°F) 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.

## 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.

### **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.

**END OF SECTION**

**1 General**

**1.1 GENERAL CONDITIONS AND SCOPE**

- .1 Section 230000 forms part of this Section as though written out herein in full, and is to be read in conjunction with this section.
- .2 The work to be done under this section shall include the furnishing of all labour, materials, tools and equipment required to install, program, calibrate, commission and complete the system as indicated on the drawings and specifications.
- .3 This specification describes the minimum performance and basic requirements.
- .4 This contractor to assist mechanical contractor in commissioning and balancing.

**1.2 RELATED DOCUMENTS**

- .1 All work of this Division shall be coordinated and provided by the single Building Management System (BMS) Contractor.
- .2 The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Division 23 Sections.
- .3 The work of this Division shall be as required by the Specifications, Point Schedules and Drawings.
- .4 If the BMS Contractor believes there are conflicts or missing information in the project documents, the Contractor shall promptly request clarification and instruction from the design team.

**1.3 BUILDING MANAGEMENT SYSTEM MANUFACTURER**

- .1 This system shall be provided and installed by:
  - .1 Base Bid - Johnson Controls; Metasys System Extended Architecture
  - .2 Alternate (show savings on tender form)
    - .1 None
- .2 Alternate proposals from agents, dealers, brokers or suppliers other than those listed above shall not be considered.

**1.4 BMS SYSTEM SUMMARY MANUFACTURER**

- .1 Provide Building Management System (BMS) as described by this section including but not limited to all necessary hardware, software, installation, programming, inspection and verification, calibration, commissioning, and demonstration to satisfy the functional intent and performance requirements of the sequence of operation and point lists.

- .2 The Building Management System (BMS) shall be a complete system designed for use with the NCDSB enterprise IT systems.
- .3 Devices residing on the network shall communicate directly on the IT infrastructure in the facility and with the NCDSB WAN. Contractor shall be responsible for coordination with the owner's IT staff to ensure that the BMS will perform in the owner's environment without disruption to any of the other activities.
- .4 All points of user interface shall not require the purchase of any special software from the BMS manufacturer or other software providers.
- .5 The primary point of interface shall be a standard Web Browser.
- .6 BMS shall report into the existing NCDSB Metasys ADX server.
- .7 Where necessary or as dictated elsewhere in these Specifications, Servers shall be used for the purpose of providing a location for extensive archiving of system configuration data, and historical data such as trend data and operator transactions. All data stored will be through the use of a standard data base platform: Microsoft Data Engine (MSDE)
- .8 The work of the single BMS Contractor shall be as defined individually and collectively in all Sections of this Division specifications together with the associated Point Sheets and Drawings and the associated interfacing work as referenced in the related documents.
- .9 The BMS work shall consist of the provision of all labour, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned BMS.
- .10 Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided for this Project.
- .11 Manage and coordinate the BMS work in a timely manner in consideration of the Project schedules. Coordinate with the associated work of other trades so as to not impede or delay the work of associated trades.
- .12 The BMS as provided shall incorporate, at minimum, the following integrated features, functions and services:
  - .1 Operator information, alarm management and control functions.
  - .2 Enterprise-level information and control access.
  - .3 Information management including monitoring, transmission, archiving, retrieval, and reporting functions.
  - .4 Diagnostic monitoring and reporting of BMS functions.
  - .5 Offsite monitoring and management access.
  - .6 Energy management
  - .7 Standard applications for terminal HVAC systems.
  - .8 Indoor Air Quality monitoring and control

- .13 Integrate network communications through the Owner's WAN for monitoring and control from any Owner network computer.

## 1.5 QUALITY ASSURANCE

- .1 General
  - .1 The Building Management System Contractor shall be the primary manufacturer-owned branch office that is regularly engaged in the engineering, programming, installation and service of total integrated Building Management Systems.
  - .2 The BMS Contractor shall be a recognized national manufacturer, installer and service provider of BMS.
  - .3 The BMS Contractor shall have a branch facility within a 100-mile radius of the job site supplying complete maintenance and support services on a 24 hour, 7-day-a-week basis.
  - .4 The Building Management System architecture shall consist of the products of a manufacturer regularly engaged in the production of Building Management Systems, and shall be the manufacturer's latest standard of design at the time of bid.
- .2 Quality Management Program
  - .1 Designate a competent and experienced employee to provide BMS Project Management. The designated Project Manger shall be empowered to make technical, scheduling and related decisions on behalf of the BMS Contractor. At minimum, the Project Manager shall:
    - .1 Manage the scheduling of the work to ensure that adequate materials, labor and other resources are available as needed.
    - .2 Manage the financial aspects of the BMS Contract.
    - .3 Coordinate as necessary with other trades.
    - .4 Be responsible for the work and actions of the BMS workforce on site.

## 1.6 WORK BY OTHERS

- .1 The demarcation of work and responsibilities between the BMS Contractor and other related trades shall be as outlined in the BMS RESPONSIBILITY MATRIX.

BMS RESPONSIBILITY MATRIX				
WORK	FURNISH	INSTALL	Low Volt. WIRING/TUB	LINE POWER
BMS low voltage and communication wiring	BMS	BMS	BMS	N/A
BMS conduits and raceway	BMS	BMS	BMS	BMS
Automatic control dampers (remote from HVAC)	BMS	23	BMS	BMS
Automatic control damper actuators	BMS	BMS	BMS	BMS
Automatic AHU control damper actuators	AHU	AHU	BMS	N/A
Automatic control valves	BMS	23	BMS	N/A

WORK	FURNISH	INSTALL	Low Volt. WIRING/TUB	LINE POWER
MS Current Switches.	BMS	BMS	BMS	N/A
MS Control Relays	BMS	BMS	BMS	N/A
Boiler Flow Switches. LWCO Switches	23	23	BMS	N/A
Boiler Daisy Chain Wiring	23	BMS	BMS	26
Boiler Pump Interlock C-3/B-1 C-4/B-1	N/A	N/A	BMS	26
Exhaust Fan Standalone Thermostats	BMS	BMS	BMS	BMS
All BMS Nodes, equipment, housings, enclosures and panels.	BMS	BMS	BMS	BMS
Exhaust Fan Starters HOA switches (Veris)	26	26	BMS	26
Starters, HOA switches	23/26	23/26	BMS	26
AH Freeze Stat.	23	BMS	BMS	BMS

**1.7 SUBMITTALS FOR REVIEW (SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES)**

- .1 Each submittal shall have a cover sheet with the following information provided: submittal ID number; date; project name, address, and title; BMS Contractor name, address and phone number; BMS Contractor project manager, quality control manager, and project engineer names and phone numbers.
- .2 The BMS contractor shall submit a list of all shop drawings with submittals dates within 30 days of contract award.
- .3 Provide sample Commissioning Acceptance Check Sheet: "Prepare a check sheet that includes all points for all functions of the BMS as indicated on the point list included in this specification. Submit the check sheet to the Engineer for approval. The Engineer will use the check sheet as the basis for acceptance with the BMS Contractor."
- .4 Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages. The packages shall be as reviewed and stamped by the Architect and Engineer for Contract compliance.
- .5 Allow 15 working days for the review of each package by the Architect and Engineer in the scheduling of the total BMS work.
- .6 Equipment and systems requiring approval of local authorities must comply with such regulations and be approved. Filing shall be at the expense of the BMS Contractor where filing is necessary. Provide a copy of all related correspondence and permits to the Owner.
- .7 Prepare an index of all submittals and shop drawings for the installation. Index shall include a shop drawing identification number, Contract Documents reference and item description.
- .8 The BMS Contractor shall correct any errors or omissions noted in the first review.

- .9 At a minimum, submit the following:
  - .1 BMS network architecture diagrams including all nodes and interconnections.
  - .2 Systems schematics, sequences and flow diagrams.
  - .3 Points schedule for each point in the BMS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.
  - .4 Samples of Graphic Display screen types and associated menus.
  - .5 Detailed Bill of Material list for each system or application, identifying quantities, part numbers, descriptions, and optional features.
  - .6 Control Damper Schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting, and Actuator Type.
  - .7 Control Valve Schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Design Pressure, and Actuator Type.
  - .8 Room Schedule including a separate line for each VAV box and/or terminal unit indicating location and address.
  - .9 Details of all BMS interfaces and connections to the work of other trades.
  - .10 Product data sheets or marked catalog pages including part number, photo and description for all products including software.

## **1.8 SUBMITTALS FOR PROJECT CLOSEOUT**

- .1 Provide three (3) copies of the Operation and Maintenance Manuals to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media, and include the following for the BMS provided.
- .2 Table of contents.
  - .1 As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with approved submittals.
  - .2 Manufacturers product data sheets or catalog pages for all products including software.
  - .3 System Operator's manuals.
  - .4 Archive copy of all site-specific databases and sequences.
  - .5 BMS network diagrams.
  - .6 Interfaces to all third-party products and work by other trades.
  - .7 The Operation and Maintenance Manual CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.
- .3 Provide three (3) copies of as-built system record drawings in hard copy format. Record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.
- .4 Provide Commissioning Acceptance Check Sheets
- .5 Provide Schedule of Training

.6 Provide Schedule of Maintenance.

.7 Provide certificate of Warranty.

## **1.9 WARRANTY**

.1 Warrant labour, materials and programming for specified control system free from defects for a period of 12 months after final acceptance. Failures on control systems that include all computer equipment, transmission equipment and all sensors and control devices 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.

## **1.10 CODES AND STANDARDS**

.1 Work, materials, and equipment shall comply with the local, provincial, and federal authorities' codes and ordinances and/or these plans and specifications.

## **2 Products**

### **2.1 BUILDING MANAGEMENT SYSTEM GENERAL DESCRIPTION**

.1 Building Management System General Description

.1 The Building Management System (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks.

.2 The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.

.3 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

### **2.2 BMS ARCHITECTURE**

.1 Automation Network

.1 The automation network shall be based on a PC industry standard of Ethernet TCPIIP. Where used, LAN controller cards shall be standard "off the shelf" products available through normal PC vendor channels.

- .2 The BMS shall network multiple user interface clients, automation engines, system controllers and application-specific controllers. Provide application and data server(s) as required for systems operation.
  - .3 Network Automation Engines (NAE) shall reside on the automation network.
  - .4 The automation network will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.
- .2 Control Network
- .1 Network Automation Engines shall provide supervisory control over the control network and shall support all three (3) of the following communication protocols:
    - .1 BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9.
    - .2 Control networks shall provide either "Peer-to-Peer," Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed.
    - .3 DOC Controllers shall reside on the control network.
    - .4 Control network communication protocol shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.
    - .5 A BACnet Protocol Implementation Conformance Statement shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.
    - .6 The Conformance Statements shall be submitted 10 day prior to bidding.
- .3 Integration
- .1 Hardwired
    - .1 Analog and digital signal values shall be passed from one system to another via hardwired connections.
    - .2 There will be one separate physical point on each system for each point to be integrated between the systems.
  - .2 Direct Protocol (Integrator Panel)
    - .1 The BMS system shall include appropriate hardware equipment and software to allow bi-directional data communications between the BMS system and 3rd party manufacturers' control panels. The BMS shall receive, react to, and return information from multiple building systems, including but not limited to the chillers, boilers, variable frequency drives, power monitoring system, and medical gas.
    - .2 All data required by the application shall be mapped into the Automation Engine's database, and shall be transparent to the operator.
    - .3 Point inputs and outputs from the third-party controllers shall have real-time interoperability with BMS software features such as: Control Software, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, Totalization, and Local Area Network Communications
  - .3 BACnet Protocol Integration – BACnet
    - .1 The neutral protocol used between systems will be BACnet over Ethernet and comply with the ASHRAE BACnet standard 135-2003.
    - .2 A complete Protocol implementation Conformance Statement (PICS) shall be provided for all BACnet system devices

- .3 The ability to command, share point object data, change of state (COS) data and schedules between the host and BACnet systems shall be provided
- .4 User Interface
  - .1 Dedicated Web Based User Interface
    - .1 Owner shall provide personal computer workstation.
    - .2 BMS Contractor shall provide and install software for command entry, information management, network alarm management, and database management functions. All real-time control functions, including scheduling, history collection and alarming, shall be resident in the BMS Network Automation Engines to facilitate greater fault tolerance and reliability.
  - .2 Distributed Web Based User Interface
    - .1 All features and functions of the dedicated user interface previously defined in this document shall be available on any computer connected directly or via a wide area or virtual private network (WANNPN) to the automation network and conforming to the following specifications.
- .5 User Interface Application Components
  - .1 Operator Interface
    - .1 An integrated browser based client application shall be used as the user operator interface program.
    - .2 All Inputs, Outputs, Setpoints, and all other parameters as defined within Part 3, shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software.
    - .3 The user interface software shall provide help menus and instructions for each operation and/or application.
    - .4 All controller software operating parameters shall be displayed for the operator to view/modify from the user Interface. These include: setpoints, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.
    - .5 The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:
      - a. User access for selective information retrieval and control command execution.
      - b. Monitoring and reporting.
      - c. Alarm. non-normal. and return to normal condition annunciation.
      - d. Selective operator override and other control actions.
      - e. Information archiving, manipulation, formatting, display and reporting.
      - f. FMS internal performance supervision and diagnostics.
      - g. On-line access to user HELP menus
      - h. On-line access to current FMS as-built records and documentation
      - i. Means for the controlled re-programming, re-configuration of FMS operation and for the manipulation of FMS database information in compliance with the prevailing codes, approvals and regulations for individual FMS applications.
  - .6 The operation of the control system shall be independent of the user interface, which shall be used for operator communications only. Systems that rely on an operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.

- .2 Navigation Trees
  - .1 The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the networks.
  - .2 Provide the ability for the operator to add custom trees. The operator will be able to define any logical grouping of systems or points and arrange them on the tree in any order. It shall be possible to nest groups within other groups. Provide at minimum 5 levels of nesting.
  - .3 The navigation trees shall be "dockable" to other displays in the user interface such as graphics. This means that the trees will appear as part of the display, but can be detached and then minimized to the Windows task bar or closed altogether. A simple keystroke will reattach the navigation to the primary display of the user interface.
- .3 Alarms
  - .1 Alarms shall be routed directly from Network Automation Engines to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the user interface shall, at the minimum, provide the following functions:
    - a. Log date and time of alarm occurrence.
    - b. Generate a "Pop-Up" window, with audible alarm, informing a user that an alarm has been received.
    - c. Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
    - d. Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm and a time/date stamp.
    - e. Provide the ability to direct alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop up window described above. Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.
    - f. Any attribute of any object in the system may be designated to report an alarm.
  - .2 The BMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions.
  - .3 The BMS shall annunciate application alarms at minimum, as required.
- .6 Reports and Summaries
  - .1 Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:
    - .1 All points in the BMS.
    - .2 All points in each BMS application.
    - .3 All points in a specific controller.
    - .4 All points in a user-defines group of points.
    - .5 All points currently in alarm.
    - .6 All points locked out.
    - .7 All BMS schedules.
    - .8 All user defined and adjustable variables, schedules, interlocks and the like.
  - .2 Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.
  - .3 Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary on the system printer for use as a building management and diagnostics tool.

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

- .9 Dynamic Color Graphics
  - .1 The graphics application program shall be supplied as an integral part of the User Interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.
  - .2 The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed. The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered.
  - .3 Graphics runtime functions- A maximum of 16 graphic applications shall be able to execute at any one time on a user interface or workstation with 4 visible to the user. Each graphic application shall be capable of the following functions:
    - .1 All graphics shall be fully scalable
    - .2 The graphics shall support a maintained aspect ratio.
    - .3 Multiple fonts shall be supported.
    - .4 Unique background shall be assignable on a per graphic basis.
    - .5 The color of all animations and values on displays shall indicate if the status of the object attributes.
  - .4 Operation from graphics- It shall be possible to change values '(setpoints) and states in system controlled equipment by using drop-down windows accessible via the pointing device.
- .10 Historical Trending and Data Collection
  - .1 Each Automation Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:
    - .1 Any point, physical or calculated, may be designated for trending. Three methods of collection shall be allowed: Defined time interval, Upon a change of value.
    - .2 Each Automation Engine shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.
    - .3 Trend and change of value data shall be stored within the engine and uploaded to a dedicated trend database or exported in a selectable data format via a provided data export utility. Uploads to a dedicated database shall occur based upon one of the following: user-defined interval, manual command, or when the trend buffers are full. Exports shall be as requested by the user or on a time scheduled basis.

## 2.3 NETWORK AUTOMATION ENGINE

- .1 The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.
- .2 Automation network- The NAE shall reside on the automation network and shall support a subnet of system controllers.
- .3 User Interface- Each NAE shall have the ability to deliver a web based User Interface (Uf) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.
  - .1 The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.

- .2 The NAE shall support a minimum of five (5) concurrent users.
  - .3 The web based user shall have the capability to access all system data through one NAE.
  - .4 Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.
  - .5 Systems that require the user to address more than one NAE to access all system information are not acceptable.
  - .6 The NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.
  - .7 Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.
  - .8 The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
    - a. Configuration
    - b. Commissioning
    - c. Data Archiving
    - d. Monitoring
    - e. Commanding
    - f. System Diagnostics
  - .9 Systems that require workstation software or modified web browsers are not acceptable.
  - .10 The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.
- .4 Processor – The NAE shall be microprocessor-based with a minimum work size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.
- .5 Memory – Each NAE shall have sufficient memory to support its own operating system databases, and control programs, and to provide supervisory control for all control level devices.
- .6 Hardware Real Time Clock – The NAE shall include an integrated, hardware-Based, real time clock.
- .7 The NAE shall include the troubleshooting LED indicators to identify the following conditions:
- .1 Power – On/Off
  - .2 Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic
  - .3 Ethernet Connection Speed – 10 Mbps/100 Mbps
  - .4 FC Bus – Normal Communications/No Field Communications
  - .5 Peer Communication – Data Traffic Between NAE Devices
  - .6 Run – NAE Running/NAE In Startup/NAE Shutting Down/Software Not Running
  - .7 Bat Fault – Battery Defective, Data Protection Battery Not Installed
  - .8 Fault – General Fault
  - .9 Modem RX – NAE Modem Receiving Data
  - .10 Modem TX – NAE Modem Transmitting Data

- .8 Communications Ports – The NAE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator’s terminals.
  - .1 USB port
  - .2 URS-232 serial data communication port
  - .3 RS-485 port
  - .4 Ethernet port
  
- .9 Diagnostics - The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
  
- .10 Power Failure- In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
  - .1 During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
  - .2 Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft- start sequence.
  
- .11 Certification – The NAE shall be listed by Underwriters Laboratories (UL).
  
- .12 Controller network – The NAE shall support the following communication products on the controller network:
  - .1 The NAE shall support BACnet Standard MSITP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

## **2.4 DOC SYSTEM CONTROLLERS**

- .1 Field Equipment Controller (FEC)
  - .1 The Field Equipment Controller shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol
  - .2 The FEC shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DOC shall provide separate control strategy diagrams for all controlled functions in their submittals.
  - .3 Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.
  - .4 The FEC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
  - .5 The FEC shall include a removable base to allow pre-wiring without the controller.

- .6 The FEC shall include troubleshooting LED indicators to identify the following conditions:
  - .1 Power On
  - .2 Power Off
  - .3 Download or Startup in progress, not ready for normal operation
  - .4 No Faults
  - .5 Device Fault
  - .6 Field Controller Bus – Normal Data Transmission
  - .7 Field Controller Bus – No Data Transmission
  - .8 Field Controller Bus – No Communication
  - .9 Sensor-Actuator Bus – Normal Data Transmission
  - .10 Sensor-Actuator Bus – No Data Transmission
  - .11 Sensor-Actuator Bus – No Communication
- .7 The FEC shall accommodate the direct wiring of analog and binary 1/0 field points.
- .8 The FEC shall support the following types of inputs and outputs:
  - .1 Universal Inputs -shall be configured to monitor any of the following:
    - .a Analog Input, Voltage Mode
    - .b Analog Input, Current Mode
    - .c Analog Input, Resistive Mode
    - .d Binary Input, Dry Contact Maintained Mode
    - .e Binary Input, Pulse Counter Mode
  - .2 Binary Inputs – shall be configures to monitor either the following:
    - .a Dry Contact Maintained Mode
    - .b Pulse Counter Mode
  - .3 Analog Outputs – shall be configured to output with of the following:
    - .a Analog Output, Voltage Mode
    - .b Analog Output, current Mode
  - .4 Binary Outputs – shall output the following:
    - .a 24 VAC Triac
  - .5 Configurable Outputs – shall be capable of the following:
    - .a Analog Output, Voltage Mode
    - .b Binary Output Mode
- .9 The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).
  - .1 The FC Bus shall be a Master-Slave/Token-Passing (MSITP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
  - .2 The FC Bus shall support communications between the FECs and the NAE.
  - .3 The FC Bus shalt also support Input/Output Module (10M) communications with the FEC and with the NAE.
  - .4 The FC Bus shall support a minimum of 100 IOMs and FEC in any combination.
  - .5 The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.
- .10 The FEC shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).
  - .1 The SA Bus shall be a Master-Slave/Token-Passing (MSITP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
  - .2 The SA Bus shall support a minimum of 10 devices per trunk.

- .3 The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FEC and the furthest connected device.
- .11 The FEC shall have the capability to execute complex control sequences involving direct wired 110 points as well as input and output devices communicating over the FC Bus or the SA Bus.
- .12 The FEC shall support, but not be limited to, the following:
  - .1 Hot water, chilled water/central plant applications
  - .2 Built-up air handling units for special applications
  - .3 Terminal units
  - .4 Special programs as required for systems control

## 2.5 FIELD DEVICES

- .1 Input/Output Mode
  - .1 The Input/Output Module (IOM) provides additional inputs and outputs for use in the FEC.
  - .2 The IOM shall communicate with the FEC over either the FC Bus or the SA Bus using BACnet Standard protocol SSPC-135, Clause 9.
  - .3 The IOM shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
  - .4 The IOM shall have a minimum of 4 points to a maximum of 17 points.
  - .5 The IOM shall support the following types of inputs and outputs:
    - .1 Universal Inputs - shall be configured to monitor any of the following:
      - .a Analog Input, Voltage Mode
      - .b Analog Input, Current Mode
      - .c Analog Input, Resistive Mode
      - .d Binary Input, Dry Contact Maintained Mode
      - .e Binary Input, Pulse Counter Mode
    - .2 Binary Inputs- shall be configured to monitor either of the following:
      - .a Dry Contact Maintained Mode
      - .b Pulse Counter Mode
    - .3 Analog Outputs – shall be configured to output either of the following:
      - .a Analog Output, Voltage Mode
      - .b Analog Output, Current Mode
    - .4 Binary Outputs – shall output the following:
      - .a 24 VAC Triac
    - .5 Configurable Outputs – shall be capable of the following:
      - .a Analog Output Voltage Model
      - .b Binary Output Model
    - .6 The IOM shall include troubleshooting LED indicators to identify the following conditions:
      - .a Power On
      - .b Power Off
      - .c Download or Startup in progress, not ready for normal operation
      - .d No Faults
      - .e Device Fault
      - .f Normal Data Transmission

- .g No Data Transmission
- .h No Communication
  
- .2 Networked Thermostat (TEC)
  - .1 The Networked Thermostats shall be capable of controlling the following:
    - .1 A four pipe fan coil system with multi-speed fan control.
    - .2 A pressure dependent Variable Air Volume System or similar zoning type system using reheat.
    - .3 A two pipe fan coil with a single speed fan.
  - .2 The Networked Thermostat shall communicate over the Field Controller Bus using BACnet Standard protocol SSPC-135, Clause 9.
    - .1 The Networked Thermostat shall support remote read/write and parameter adjustment from the web based User Interfaceable through a Network Automation Engine.
  - .3 The Networked Thermostat shall include an intuitive User Interface providing plain text messages.
    - .1 Two line, 8 character backlit display
    - .2 LED indicators for Fan, Heat, and Cool status
  - .4 Five (5) User Interface Keys
    - .1 Mode
    - .2 Fan
    - .3 Override
    - .4 Degrees C/F
    - .5 Up/Down
  - .5 The display shall continuously scroll through the following parameters:
    - .1 Room Temperature
    - .2 System Mode
    - .3 Schedule Status – Occupied/Unoccupied/Override
    - .4 Applicable Alarms
  - .6 The Networked Thermostats shall provide the flexibility to support the following inputs:
    - .1 Integral Indoor Air Temperature Sensor
    - .2 Duct Mount Air Temperature Sensor
    - .3 Remote Indoor Air Temperature Sensor with Occupancy Override and LED Indicator.
    - .4 Two configurable binary inputs
  - .7 The Networked Thermostats shall provide the flexibility to support the following outputs:
    - .1 Three Speed Fan Control
    - .2 On/Off Control
    - .3 Floating Control
    - .4 Proportional (0 to 10V) Control
  - .8 The Networked Thermostat shall provide a minimum of six (6) levels of keypad lockout.
  - .9 The Networked Thermostat shall provide the flexibility to adjust the following parameters:
    - .1 Adjustable Temporary Occupancy from 0 to 24 hours
    - .2 Adjustable heating/cooling deadband from 2° F to 5° F
    - .3 Adjustable heating/cooling cycles per hour from 4 to 8

- .10 The Networked Thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.

## 2.6 THIRD PARTY INTERFACES

- .1 BMS Contractor shall integrate real-time data, via BACnet MS/TP, from systems supplied by other trades as required, include but not limited to Air Cooled Chiller (CH1)
- .2 The BMS system shall include necessary BMS hardware equipment and software to allow data communications between the BMS system and systems supplied by other trades.
- .3 The trade contractor supplying other systems will provide their necessary hardware and software at no cost to the BMS Contractor and will cooperate fully with the BMS contractor in a timely manner at their cost to ensure complete data integration.

## 2.7 APPLICATION SOFTWARE

- .1 Event Messaging: Provide for the automatic execution of user-defined messages on the occurrence of each predefined BMS real-time event including equipment/point status change, approaching limit or alarm, time of day and the like. Direct messages to any number of operator PCs, e-mail destinations, and pagers.
- .2 Indoor Air Quality: As specified, provide monitoring of return air CO<sub>2</sub> concentration, calculate and maintain fresh air requirements. Adjust outdoor air intake to ensure return air CO<sub>2</sub> high level limit is not exceeded.
- .3 Optimum Start/Stop: Provide software to start equipment on a sliding schedule based upon indoor and outdoor conditions, to determine the minimum time of HVAC system operation needed to satisfy the space environmental requirements. The program shall also determine the earliest possible time to stop the mechanical systems. The optimum start/stop program shall operate in conjunction with, and be coordinated with, the scheduled start/stop and night setback programs.
- .4 Event Initiated Programs and custom logic: Provide software to define custom logic sequences that will reside in the nodes. The definition software will also reside in the node and be accessible via the standard user interface via a browser.
- .5 System Restart: Upon restoration of the AC power to an HVAC Node, automatically restart all equipment and restore all loads to the state as required by the BMS. Provide appropriate time delays to prevent demand surges or overload trips.
- .6 Heavy Equipment Delays: The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

- .7 Runtime Totalization: Automatically sample, calculate and store runtime hours for binary input and output points as listed in the point schedule of this specification.

## 2.8 INPUT DEVICES

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

Point Type	Accuracy
Hot Water Temperature	± .5°F
Room Temp	±.5°F.
Duct Temperature	±.5°F.
All Others	±.75°F.

- .3 Room Temperature Sensors
  - .1 Space Sensors/Room Temperature Sensors:
    - .1 Room sensors shall be constructed for either surface or wallbox mounting.
    - .2 Room sensors shall have the following capabilities:
      - .a Adjust room setpoint, software limited to +/- 3°F.
      - .b LCD temperature display.
      - .c Timed override request push button.
  - .2 Provide lockable tamper-proof covers in public area and/or where indicated on the plans.
- .4 Thermo wells
  - .1 When thermo wells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and Greenfield fitting.
  - .2 Thermo wells shall be pressure rated and constructed in accordance with the system working pressure.
  - .3 Thermo wells and sensors shall be mounted in a threadolet or 1/2" NPT saddle and allow easy access to the sensor for repair or replacement.
  - .4 Thermo wells shall be constructed of 316 stainless steel.

- .5 Outside Air Sensors
  - .1 Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
  - .2 Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
  - .3 Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.
  
- .6 Duct Mount Sensors
  - .1 Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
  - .2 Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
  - .3 For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.
  
- .7 Averaging Sensors
  - .1 For ductwork greater in any dimension than 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
  - .2 For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.
  - .3 Capillary supports at the sides of the duct shall be provided to support the sensing string.
  
- .8 Carbon Dioxide Transmitter
  - .1 Material: Duct probe meets plenum rating requirements of UL 1995, Heating and Cooling Equipment.
  - .2 Mounting: Duct Insertion or Wall
  - .3 Range: 0 to 2,000 ppm CO<sub>2</sub>
  - .4 Accuracy:  $\pm 30$  ppm CO<sub>2</sub> + 2.0% of reading
  - .5 Protection: Maximum Output Current: 25 mA; Maximum Output Voltage: 12.5V
  - .6 Output: Jumper Selectable: 0 to 20 mA or 4 to 20 mA or 0 to 10 VDC
  - .7 Special: Long-Term Stability  $\pm 5.0\%$  of Full Scale/5 Years

## 2.9 OUTPUT DEVICES

- .1 Installation, testing, and calibration of output devices shall be provided to meet the system requirements.
  
- .2 Actuators
  - .1 General Requirements
    - .1 Damper and valve actuators shall be electronic and/or pneumatic, as specified in the System Description section.
  
- .3 Electronic Damper Actuators
  - .1 Electronic damper actuators shall be direct shaftmount.

- .4 Electronic Valve Actuators
  - .1 Electronic valve actuators shall be manufactured by the valve manufacturer.
  - .2 Each actuator shall have current-limiting circuitry incorporated in its design to prevent damage to the actuator.
- .5 Control Dampers
  - .1 The BMS Contractor shall furnish all automatic dampers. Automatic dampers shall be sized for the application by the BMS Contractor or as specifically indicated on the Drawings.
  - .2 Dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.
  - .3 Dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.
  - .4 Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 60". Damper blades shall be 16-gauge minimum and shall not exceed eight (8) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. Damper bearings shall be made of reinforced nylon, stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and flexible stainless steel side seals. Dampers of 48"x48" size shall not leak in excess of 8.0 cfm per square foot when closed against 4" w.g. static pressure when tested in accordance with AMCA Std. 500.
  - .5 Insulated dampers shall be used for outdoor air and exhaust air.
  - .6 Airfoil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5" w.g., but no more than 4000 FPM or 6" w.g. or shut off against outdoor air.
  - .7 One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below.
  - .8 Multiple section dampers may be jack-shafted to allow mounting of direct connect electronic actuators. Each end of the jackshaft shall receive at least one actuator to reduce jackshaft twist.
- .6 Control Valves
  - .1 All automatic control valves shall be fully proportioning and provide near linear heat transfer control. The valves shall be quiet in operation and fail-safe open, closed, or in their last position. All valves shall operate in sequence with another valve when required by the sequence of operations. All control valves shall be sized by the control manufacturer, and shall be guaranteed to meet the heating and cooling loads, as specified. All control valves shall be suitable for the system flow conditions and close against the differential pressures involved. Body pressure rating and connection type (sweat, screwed, or flanged) shall conform to the pipe schedule elsewhere in this Specification.
  - .2 Heating water control valves shall be modulating plug, or ball, as required by the specific application. Modulating water valves shall be sized per manufacturer's recommendations for the given application. In general;

- .1 Valves (2 or 3-way) serving variable flow air handling unit coils shall be sized for a pressure drop equal to the actual coil pressure drop, but no more than 3 PSI.
- .2 Valves (3-way) serving constant flow air handling unit coils with secondary circuit pumps shall be sized for a pressure drop equal to 25% the actual coil pressure drop, but no less than 2 PSI.
- .3 Mixing valves (3-way) serving secondary water circuits shall be sized for a pressure drop of no more than 3 PSI.
- .4 Valves for terminal reheat coils or radiant panels shall be sized for a 1 PSIG pressure drop.
- .3 Ball valves may be used for hot water applications, water terminal reheat coils, radiant panels, unit heaters, package air conditioning units, and fan coil units except those described hereinafter.
- .4 Modulating plug water valves of the single-seat type with equal percentage flow characteristics shall be used for all special applications as indicated on the valve schedule. Valve discs shall be composition type. Valve stems shall be stainless steel.

### **3 Performance/Execution**

#### **3.1 BUILDING MANAGEMENT SYSTEMS**

- .1 BMS Specific Requirements
  - .1 Graphic Displays
    - .1 Provide a color graphic system flow diagram display for each system with all points as indicated on the point list All terminal unit graphic displays shall be from a standard design library.
    - .2 User shall access the various system schematics via a graphical penetration scheme and/or menu selection.
  - .2 BMS Wiring
    - .1 Conduit, wiring, accessories and wiring connections required for the installation of the Building Management System, as herein specified, shall be provided by the BMS Contractor unless specifically shown on the Electrical Drawings under Division 260000 Electrical.
    - .2 Wiring shall comply with the requirements of applicable portions of Division 260000 and all local and national electric codes.
    - .3 BMS wiring materials and installation methods shall comply with BMS manufacturer recommendations. Discrepancies shall be brought to the attention of the Engineer.
    - .4 The sizing type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the BMS Contractor.
    - .5 Wiring in Classrooms: All Class 2 (24VAC or less) wiring for space sensors shall be installed in EMT conduit within masonry walls or within wall cavity. Within Boiler Rooms and Air Handling Rooms conduit may be installed surface mounted. In concealed but accessible spaces, low Voltage wiring may be FT-6 plenum wire.

- .6 Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.
- .3 BMS Line Voltage Power Source
- .1 120-volt AC circuits used for the Building Management System shall be taken from panelboards and circuit breakers provided by Electrical Division.
- .2 Circuits used for the BMS shall be dedicated to the BMS and shall not be used for any other purposes.
- .4 Penetrations
- .1 Provide firestopping for all penetrations used by dedicated BMS conduits and raceways. All other project firestopping to be by other trade.
- .2 Openings in fire proofed or fire stopped components shall be closed by using approved fire resistive methods.
- .3 Wiring passing through penetrations, including walls, shall be in conduit or enclosed raceway.
- .4 Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.
- .5 No penetrations in structural elements shall be made before receipt of written approval from the architect and/or structural engineer.
- .5 BMS Identification Standards
- .1 Node Identification. All nodes shall be identified by a permanent label fastened to the outside of the enclosure. Labels shall be suitable for the node location.
- .2 Each of the cable types specified in Item A shall be of a different color coding for easy identification and troubleshooting.
- .3 Wire Identification. All low and line voltage BMS wiring shall be identified by a number, as referenced to the associated shop drawing and as-built drawing, at each end of the conductor or cable. Identification number shall be permanently secured to the conductor or cable and shall be typed.
- .4 Field Devices. All field devices shall be identified by a typed (not typewritten) securely attached tag label.
- .6 BMS Node Installation
- .1 BMS panels and cabinets shall be located as indicated and at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.
- .2 The BMS contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.
- .7 Input Devices
- .1 All Input devices shall be installed per the manufacturer recommendation.
- .2 Locate components of the BMS in accessible local control panels wherever possible.
- .3 The mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.
- .4 Input Flow Measuring Devices shall be installed in strict compliance with ASME guidelines affecting non-standard approach conditions.

- .5 Outside Air Sensors
  - .1 Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately.
  - .2 Sensors shall be installed with a rain proof, perforated cover.
- .6 Water Differential Pressure Sensors
  - .1 Differential pressure transmitters used for flow measurement shall be sized to the flow-sensing device.
  - .2 Differential pressure transmitters shall be supplied with tee fittings and shut-off valves in the high and low sensing pick-up lines.
  - .3 The transmitters shall be installed in an accessible location wherever possible.
- .7 Duct Temperature Sensors:
  - .1 Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.
  - .2 The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate.
  - .3 For ductwork greater in any dimension than 48 inches or where air temperature stratification exists such as a mixed air plenum, utilize an averaging sensor.
  - .4 The sensor shall be mounted to suitable supports using factory approved element holders.
- .8 Space Sensors:
  - .1 Mounting height shall be per ADA and NCDSB requirements.
  - .2 Provide lockable tamper-proof covers in public areas and/or where indicated on the plans and in public spaces.
- .9 Low Temperature Limit Switches:
  - .1 Install on the discharge side of the first water or steam coil in the air stream.
  - .2 Mount element horizontally across duct in a serpentine pattern insuring each square foot of coil is protected by 1 foot of sensor.
  - .3 For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.
- .10 Air Differential Pressure Status Switches
  - .1 Install with static pressure tips, tubing, fittings, and air filter.
- .11 Water Differential Pressure Status Switches:
  - .1 Install with shut off valves for isolation.
- .8 HVAC Output Devices
  - .1 All output devices shall be installed per the manufacturers recommendation. The mechanical contractor shall install all in-line devices such as control valves, dampers, airflow stations, pressure wells, etc.
  - .2 Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke.
  - .3 Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.
  - .4 Control Valves: Shall be sized for proper flow control with equal percentage valve plugs. The maximum pressure drop for water applications shall be PSI.

### 3.2 TRAINING

- .1 Provide on-site training services:
  - .1 Two 4 hour (1/2) days of on-site orientation by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the BMS software layout and naming conventions, and a walk through of the facility to identify panel and device locations.

### 3.3 COMMISSIONING

- .1 Fully commission all aspects of the Building Management System work.
- .2 Acceptance Check Sheet: Prepare a check sheet that includes all points for all functions of the BMS as indicated on the point list included in this specification. Submit the check sheet to the Engineer for approval. The Engineer will use the check sheet as the basis for acceptance with the BMS Contractor.
  - .1 Low Temperature Limit Switches:
    - .1 Install on the discharge side of the first water or steam coil in the air stream.
    - .2 Mount element horizontally across duct in a serpentine pattern insuring each square foot of coil is protected by 1 foot of sensor.
    - .3 For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.
  - .2 Carbon Dioxide Transmitters:
  - .3 Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.
  - .4 The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate.

### 3.4 SEQUENCES OF OPERATION

#### NOTE:

- .1 All systems to be in UNOCCUPIED MODE on weekends, holidays, PA days, statutory days and other days when students not at school.
- .2 All equipment to be off during Summer Months when students not at school.
- .3 Chiller shall be commanded off during Summer Months.
- .4 Building Operator and/or timed override shall be able to switch systems to OCCUPIED MODE.

#### .1 BOILER PLANT – HOT WATER HEATING SYSTEM

##### Heating/Cooling Switchover

- .1 Building operator shall open switchover isolation valves and manually change BMS sequences from cooling to heating (summer/winter) on a seasonal basis.

##### Hot Water Primary Pump Control

- .1 Primary Pumps (C-1, C-2) are started, stopped and rotated manually by the Caretaker.
- .2 Monitor Pump status and display accumulated run time for operator. BMS to provide indication when lead pump is to be rotated.

### **Hot Water Heat Control**

- .1 Integral Boiler controller at Lead boiler shall stage member boilers to maintain supply water temperature.
- .2 BMS shall enable/disable boiler plant controls.
- .3 BMS shall reset supply water temperature to maintain lowest return water temperature possible in heating mode, for condensing boilers, while maintaining occupant comfort.
- .4 The boiler control sequence will begin when either one of the hot water pumps has a status of on.
- .5 The boiler pump shall be interlocked with the respective boiler and shall delay off through integral boiler controller.
- .6 Return water setpoint is reset inversely, from 80F to 160F, as the outdoor air temperature falls from 40F to -10F (setpoints are adjustable).
- .7 The boilers safeties circuit will be monitored and the system will report a general alarm condition if a safety is tripped. A manual reset of the boiler safety will be required before the boiler will can be restarted.
- .8 Provide indication of the outdoor air temperature and the boiler loop supply temperature and return water temperature, boiler alarm status, primary pumps status, program times and set points at the BMS.

### **.2 HVAC-1 VARIABLE VOLUME UNIT CONTROL WITH REMOTE VARIABLE FREQUENCY DRIVES (HVAC-2 Similar)**

- .1 The air handling unit consists of a mixed air section with return fan, outdoor air, exhaust and return air dampers, filter, DX cooling coil, supply fan, and gas fired fully modulating heating section The unit is DDC controlled using electronic actuation. The supply and return fan is wired through their respective remote VFD's interlocked through the BAS control. The dampers are controlled through the BAS system.
- .2 The air handling unit is scheduled for automatic operation on a time of day basis for Occupied and Unoccupied modes. Within the Occupied mode, the system can enter the Warm-Up mode when the space temperature is below set point or the Cool-Down mode when the space temperature is above set point. The system stays in the Warm-Up or Cool-Down mode until the mode set point is satisfied. Within the Unoccupied mode, Night Heating is available when the space temperature drops below 65 degrees F (18 degrees C). The latest start time is the scheduled occupancy for the space.
- .3 The air handling unit operates in Warm-Up, Cool-Down, Occupied, Unoccupied, Night Heating and Safety modes as follows (All suggested set points and settings are adjustable.):

#### **Warm-Up**

The supply fan starts. The mixing dampers are positioned for 100% return air. The gas valve modulates to maintain the supply air temperature set point. If time reaches the latest start time during the Warm-Up mode, the outdoor air damper opens to its minimum position. The system is prevented from entering the Warm-Up mode more than once per day.

### **Cool-Down**

The supply fan starts. The heating valve remains closed to the coil. The mixing dampers and DX valve(s) modulate to maintain the supply air temperature set point. When the outside air dry bulb temperature is above the economizer changeover value, the mixing dampers are positioned for 100% return air. If time reaches the latest start time during the Cool-Down mode, the outdoor air damper opens to its minimum position or is controlled in economizer operation. The system is prevented from entering the Cool-Down mode more than once per day.

### **Unoccupied Mode**

The supply and return fan is off and the mixing dampers are in the 100% recirculation position and the DX valve(s) are closed.

### **Occupied Mode**

An optimized start routine is provided. During morning warm-up or cool-down the outside air minimum position is set to zero. Supply and return fans run continuously. A duct mounted static pressure sensor located where indicated maintains duct pressure through the supply and return fan variable frequency drives. Supply air temperature discharge sensor operates the modulating gas valve, the DX cooling valve(s), and the mixing dampers (for mixed air temperature and/or free cooling) in sequence to maintain setpoint which is reset from outside air temperature as follows:

<u>OAT</u>	<u>SAT</u>
22°C	13°C
10°C	18°C

### **Room Sensor**

A room sensor controls the space temperature through a VAV box with hot water heating coil and/or remote radiation as indicated and as specified elsewhere.

Supply air static pressure sensor controls supply fan speed to maintain setpoint (initially 1inwg) through the VFD controller. Return flow station controls return fan speed through the VFD controller to maintain setpoint (which is calculated from supply air flow minus exhaust air quantity).

A CO2 sensor in the return air stream shall override the mixing damper set point and modulate the dampers open upon sensing a rise in the return air CO2 level above the return air CO2 level set point.

### **Safety**

All of the safety devices are manual reset; the device that has tripped must be manually reset before restarting the air handling unit.

When the OAT is less than 50 degrees F (10 degrees C), the gas valve and dampers modulates to maintain the mixed air temperature at 50 degrees F (10 degrees C). When the OAT is 50 degrees F (10 degrees C) or above, the gas valve closes. All other dampers and valves position to their normal position after the fans are de-energized.

A hard wired low temperature detector in the discharge duct de-energizes the supply fan when temperatures below 38 degrees F (3 degrees C) are sensed.

If a temperature low limit switch senses a temperature below setpoint the supply fan and return fan will be shutdown. (low limit switch is complete with AH).

Fire alarm system activation will shutdown the fan system.

### Schedule

- |    |             |   |
|----|-------------|---|
| .1 | Occupied:   | 8:00 a.m. – 3:30 p.m., continuous fan operation |
|    |             | Space temperature: Cooling 75°F                 |
|    |             | Heating 70°F                                    |
| .2 | Unoccupied: | Heating – Cycle fan in heating                  |
|    |             | Cooling – Fan off                               |
|    |             | Space temperature: Cooling 85°F                 |
|    |             | Heating 66°F                                    |

### Shutdown

When the unit is shutdown by either a stop command or system safety the unit will be set as follows:

- .1 Supply fan will be off (electrically interlocked return fan will be off)
- .2 Outside air damper will close
- .3 Return air damper will open
- .4 Exhaust air damper will close
- .5 Heating gas valve will be energized.

### Alarm Monitoring

An alarm is generated whenever the supply fan or return fan fails to respond to supply fan start-stop command.

An alarm is generated when the low temperature thermostat is triggered.

## .3 ERV UNITS (ERV-1)

### Supply Fan Start/Stop

The supply fan will be started according to the schedule. If the supply fan status does not match the commanded value, an alarm will be generated. When the supply fan status indicates the fan started, the control sequence will be enabled.

### Exhaust Fan Start/Stop

When the supply fan is commanded, the Division 26 electrically interlocked return fan will start. If the return fan status does not match the commanded value, an alarm will be generated.

### Energy Recovery Wheel

- .1 Wheel will be started according to schedule. Damper control bypass damper, return damper, outdoor damper and defrost cycled are by BMS.
- .2 When Outside Air Temperature (OA-T) is greater than the Return Air Temperature (RA-T), rotate energy wheel and close by-pass damper.
- .3 When OA-T is greater than 10°C and less than the RA-T, stop energy wheel and open bypass damper.
- .4 When OA-T is less than 10°C, rotate energy wheel and modulate by-pass damper to control wheel capacity.
- .5 When OA-T is less than 4°C, rotate energy wheel and close by-pass damper.

- .6 When OA-T is less than -15°C (frost prevention), rotate energy wheel and modulate by-pass damper to maintain HRVEA-T at -3°C.

### Discharge Air Control

- .1 Heating mode:  
.a Initiated via building operator with Summer/Winter switchover point.  
.b The energy recovery wheel, energy recovery bypass damper, heating valve, and cooling valve will be modulated in sequence to maintain the supply air temperature setpoint.
- .2 Summer mode:  
.a Initiated via building operator with Summer/Winter switchover point.  
.b The energy recovery wheel, energy recovery bypass damper, heating valve, and cooling valve will be modulated in sequence to maintain the supply air temperature setpoint.

### Safety

- .1 All of the safety devices are manual reset; the device that has tripped must be manually reset before restarting the energy recovery unit.
- .2 Fire alarm system activation will shutdown the fan system.

### Schedule

- .1 Occupied: 8:00 a.m. – 3:30 p.m., continuous fan operation  
.2 Unoccupied Unit off

### Shutdown

When the unit is shutdown by either a stop command or system safety the unit will be set as follows:

- .a Supply fan will be off (electrically interlocked exhaust fan will be off)  
.b Outside air damper will close  
.c Exhaust air damper will close  
.d Energy Wheel will be off

### Alarm Monitoring

An alarm is generated whenever the supply fan or exhaust fan fails to respond to supply fan start-stop command.

## .4 RADIANT HEATING PANEL/WALLFIN RADIATION CONTROL

### Radiation Control

Control valve will modulate to maintain zone temperature setpoint of 22°C in heating. The user by way of a local warmer/cooler adjustment will be able to add or subtract from the setpoint.

### Schedule

- .1 Occupied: Space temperature: Cooling 75°F  
Heating 70°F
- .2 Unoccupied: Heating – Cycle fan in heating  
Cooling – Fan off  
Space temperature: Cooling 85°F  
Heating 66°F

A pushbutton on the space thermostat will allow temporary occupied mode to be activated for a 2 hour period for after-hours use.

During the temporary occupied mode, the unit will function according to the occupied mode of operation. When the temporary occupancy timer expires.

**.5 EXHAUST FANS**

- .1 Provide programmable start/stop control in three groups at the OWS.
- .2 Provide dual voltage relays for exhaust fans rated for 120V/1/60. Install dual voltage relays in accessible ceiling space adjacent to exhaust fan.
- .3 Wire through dual voltage relay or magnetic starters as indicated. Magnetic starters will be provided by Division 16.
- .4 Provide override stop/start/status for fans with local control.

**.6 ROOM VAV CONTROL**

- .1 The space temperature modulates the VAV box in sequence with the heating coil and radiation (if applicable) to maintain setpoint. A velocity sensor controls the air flow between min. and max. settings.
- .2 Maintain 80% minimum air flow when OA temp is less than 10° (adj).
- .3 A velocity sensor controls the air volumes between maximum and minimum.
- .4 Provide a duct sensor in the VAV discharge duct.

**.7 FORCE FLOW HEATER CONTROL**

- .1 A temperature sensor energizes the fan to maintain setpoint.

**.8 MECHANICAL ROOM CONTROL**

- .1 Provide space sensor to control supply fan and/or motorized damper, exhaust fan, and force flow heater.
- .2 On rise in space temperature the exhaust fan(s) and supply fan(s) or motorized damper where installed are energized.
- .3 On drop in space temperature the unit heater is energized.

**.9 LAN ROOM VENTILATION (EF-2)(EF-3 Similar)**

- .1 Provide reverse acting thermostat to control exhaust fan on rise in room temperature.

**.10 DOMESTIC HOT WATER**

- .1 Provide programmable stop/start control for recirc pump.
- .2 Provide supply temperature indication.

**.11 TRAP PRIMER SOLENOID VALVE CONTROL**

- .1 Energize solenoid valve for five minutes (adj) each 24 hour period (adj) during unoccupied times.
- .2 Sequence valves so that no more than two (2) valves operate at the same time.

**.12 OUTDOOR LIGHTING CONTROL**

- .1 Provide programmable control of three (3) lighting control circuits through the OWS. Connect to nearest electrical lighting control panel where indicated:
  - Exterior lighting (photocell), 1 point
  - Security/fire alarm signal, 1 point

.2 Provide a photo cell to inhibit the operation of the exterior lighting circuits a light levels above the photocell setpoint.

**.13 SECURITY SYSTEM**

.1 Provides connection to security system panel.

**.14 FIRE ALARM**

.1 Provide connection to fire alarm panel.

**.15 BUILDING LOW TEMPERATURE**

.1 All space sensors shall be capable of indicating building low temperature. Alarm building low temperatures at OWS.

**.16 KITCHEN MUA UNIT(MUA-1)/EXHAUST FAN (EF-7)**

.1 Provide Stop/Start/Status (CSR) control.

.2 Provide indication and/or reset discharge air temperature.

.3 Provide alarms at operator work stations.

.4 Provide CSR on kitchen hood exhaust fan.

.5 When the kitchen exhaust fan is started through the stop start pushbutton mounted adjacent to the hood, the MUA unit is energized on proof of exhaust air flow. The stop/start pushbutton will be by Division 16. The magnetic starter will be by Division 16 located in the kitchen ceiling space.

.6 The MUA unit maintains a discharge temperature through a duct mounted discharge sensor which modulates the electric resistance heater (MUA-1) to maintain setpoint.

**3.5 ELECTRICAL**

.1 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. Refer to equipment wiring schedule or electrical drawings for wiring responsibilities.

.2 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.

.3 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.

- .4 Wiring: All electric wiring in connection with this project shall be furnished and installed under this section.
  - .1 The Contractor shall be aware that cables carrying high currents run through ceiling and wall cavities. Signal interference or sensor inaccuracy or failure caused by existing cable runs shall be the responsibility of the Contractor and shall be covered under the warranty.  
The Contractor shall select sensors and use shielded cable or transmitters as necessary to prevent electrical interference with the control system operation.
  - .2 The Contractor shall coordinate fully the interconnection of factory assembled portions of system controls, field installed control systems and the electrical power system to provide a complete working installation.
  - .3 Power for control equipment shall not be taken from equipment motor leads. Power shall be from circuits dedicated for controls only.
  - .4 Transformers shall be sized for 150% of engineered capacity.
  - .5 All wires are to be numbered using wire labels at each end. These labels shall correspond to wire identification on the shop drawings and "as-built" drawings.
- .5 Electrical Isolation of I/O Points: To prevent serious damage to the field panels from surges, or RFI electrically induced spikes, protection in the following form shall be provided, as a minimum:
  - .1 Digital outputs singularly or collectively shall be galvanically isolated from the main panel processor.
  - .2 Analog outputs shall be galvanically isolated from each other and the main panel processor.
  - .3 Digital inputs shall be galvanically isolated from the main panel processor.
- .6 Panel Documentation: Mount an input/output layout sheet within each controller field panel. This sheet shall include the name of the points connected to each controller channel.
- .7 Conduits and Wiremold: All exposed wiring, whether for power, sensors, actuators, or data communications, shall be in metallic conduit or wiremold in all finished areas. 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. Supports shall be located at each connector end of each conduit. High and low voltage wire shall not be run in the same conduit.  
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.
  - .2 The Contractor may use existing unused conduit from equipment that is not longer in service, if the opportunity arises during construction.
  - .3 Wiremold shall be as specified in Division 16. Colour shall be selected by the owner.
- .8 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.

- .9 Enclosures: All enclosures shall be mounted such that the doors can open fully without interference with new or existing equipment. Except where expressly permitted in writing by the Owner or Engineer, enclosures shall be mounted in easily accessible locations where a technician can clearly see and easily access all components inside without a stool or ladder.
- .10 Power Protection: During the warranty period, the Contractor shall be responsible for parts and labour to repair or replace any system equipment damaged by power quality problems (spikes, sags, waveform anomalies, etc.). with that in mind, the Contractor shall provide appropriate power protection.
- .11 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.
- .12 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.

### 3.6 POINTS LIST

- .1 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 in the contractor in providing a complete system. It is the contractor's responsibility to ensure the BAS system is installed and operates as specified.

**END OF WRITTEN SECTION**

**REFER TO ATTACHED THREE PAGE POINTS LIST**

Our Lady of Fatima Points List							
CONTROL POINTS	DEVICE	DO	DI	AO	AI	Override Switch	Location
HVAC-1 Supply Fan Control	On/Off	1					Roof
HVAC-1 Supply Fan Status	Amperage				1		Roof
HVAC-1 Dx Cooling (provide staged cooling)	2-10 VDC Control			3			Roof
HVAC-1 Gas Heating Valve (modulating gas valve)	2-10 VDC Control			1			Roof
HVAC-1 Mixed Air Dampers	2-10 VDC Control			1			Roof
HVAC-1 Exhaust Air Dampers	2-10 VDC Control			1			Roof
HVAC-1 Supply Air Sensor	Duct Temp Sensor				1		Roof
HVAC-1 Return Air Sensor	Duct Temp Sensor				1		Roof
HVAC-1 Mixed Sensor	Averaging Sensor				1		Roof
HVAC-1 Freeze Stat Status	Duct Temp Sensor		1				Roof
HVAC-1 Supply Fan Variable Frequency Drive (Remote)	2-10 VDC Control			1			Storage Room 122
HVAC-1 Return Fan Variable Frequency Drive (Remote)	2-10 VDC Control			1			Storage Room 122
HVAC-1 Carbon Dioxide Sensor	Duct Mounted Sensor			1			Roof
HVAC-1 Return Air Fan Control	On/Off	1					Roof
HVAC-1 Return Air Fan Status	Amperage				1		Roof
HVAC-1 Space Sensor	Space Sensor				1		Refer to Plan
HVAC-2 Supply Fan Control	On/Off	1					Roof
HVAC-2 Supply Fan Status	Amperage				1		Roof
HVAC-2 Dx Cooling (provide staged cooling)	2-10 VDC Control			3			Roof
HVAC-2 Gas Heating Valve (modulating gas valve)	2-10 VDC Control			1			Roof
HVAC-2 Mixed Air Dampers	2-10 VDC Control			1			Roof
HVAC-2 Exhaust Air Dampers	2-10 VDC Control			1			Roof
HVAC-2 Supply Air Sensor	Duct Temp Sensor				1		Roof
HVAC-2 Return Air Sensor	Duct Temp Sensor				1		Roof
HVAC-2 Mixed Sensor	Averaging Sensor				1		Roof
HVAC-2 Freeze Stat Status	Duct Temp Sensor		1				Roof
HVAC-2 Supply Fan Variable Frequency Drive (Remote)	2-10 VDC Control			1			Storage Room 122
HVAC-2 Return Fan Variable Frequency Drive (Remote)	2-10 VDC Control			1			Storage Room 122
HVAC-2 Carbon Dioxide Sensor	Duct Mounted Sensor			1			Roof
HVAC-2 Return Air Fan Control	On/Off	1					Roof
HVAC-2 Return Air Fan Status	Amperage				1		Roof
HVAC-2 Space Sensor	Space Sensor				1		Refer to Plan
ERV-1 Supply Fan Control	On/Off	1					Roof
ERV-1 Supply Fan Status	Amperage				1		Roof
ERV-1 Exhaust Fan Control	On/Off	1					Roof
ERV-1 Exhaust Fan Status	Amperage				1		Roof
ERV-1 Exhaust Air Temperature	Duct Temp Sensor				1		Roof
ERV-1 Supply Air Temperature	Duct Temp Sensor				1		Roof
ERV-1 Intake Motorized Damper	2-10 VDC Control			1			Roof
ERV-1 Energy Recovery Wheel (On/Off)	On/Off	1					Roof
ERV-1 Energy Recovery Wheel Status	Amperage				1		Roof
Boiler #1 Control	On/Off	1					Mechanical Room 203
Boiler #1 Gas Valve Status	Status		1				Mechanical Room 203
Boiler #1 Alarm Circuit Status	Status		1				Mechanical Room 203
Boiler #1 Supply Sensor	Thermal Well Sensor				1		Mechanical Room 203

Our Lady of Fatima Points List							
CONTROL POINTS	DEVICE	DO	DI	AO	AI	Override Switch	Location
Boiler #2 Control	On/Off	1					Mechanical Room 203
Boiler #2 Gas Valve Status	Status		1				Mechanical Room 203
Boiler #2 Alarm Circuit Status	Status		1				Mechanical Room 203
Boiler #2 Supply Sensor	Thermal Well Sensor				1		Mechanical Room 203
Boiler Supply Water Temperature	Thermal Well Sensor				1		Mechanical Room 203
Boiler Return Water Temperature	Thermal Well Sensor				1		Mechanical Room 203
Circulating Pump C-1 Control	On/Off	1					Mechanical Room 203
Circulating Pump C-1 Status	Amperage				1		Mechanical Room 203
Circulating Pump C-2 Control	On/Off	1					Mechanical Room 110
Circulating Pump C-2 Status	Amperage				1		Mechanical Room 110
Circulating Pump C-3 Control	On/Off	1					Mechanical Room 110
Circulating Pump C-3 Status	Amperage				1		Mechanical Room 110
Circulating Pump C-4 Control	On/Off	1					Mechanical Room 203
Circulating Pump C-4 Status	Amperage				1		Mechanical Room 203
Exhaust Fan Control (EF-6)	On/Off	1					Refer To Plan - Wire Thru DVR/Starter
Exhaust Fan Status (EF-6)	Amperage				1		Refer To Plan - Wire Thru DVR/Starter
Lan Room Exhaust Fan Control (EF-2, EF-3)	Sensor	2					Refer To Plan - Wire Thru DVR/Starter
Lan Room Exhaust Fan Status (EF-2, EF-3)	Amperage				2		Refer To Plan - Wire Thru DVR/Starter
MUA-1 Control	On/Off	1					Refer To Plan - Wire Thru DVR/Starter
MUA-1 Status	Amperage				1		Refer To Plan - Wire Thru DVR/Starter
MUA_1 Supply Air Sensor	Duct Temp Sensor				1		Refer To Plan - Wire Thru DVR/Starter
MUA-1 Freeze Stat Status	Duct Temp Sensor		1				Refer To Plan - Wire Thru DVR/Starter
EF-7 Control	On/Off	1					Roof-Wire Thru Starter
EF-7 Status	Amperage				1		Roof
Mechanical Room 220 Motorized Damper	On/Off	1					Mechanical Room 220
Mechanical Room 220 Exhaust Fan Control (EF-4)	On/Off	1					Mechanical Room 220
Mechanical Room 220 Cabinet Heater	120 VDC Control			1			Mechanical Room 220
Mechanical Room 220 Space Sensor	Space Temp Sensor				1		Mechanical Room 220
Mechanical Room 220 Exhaust Fan Status (EF-4)	Amperage				1		
Childcare DHW Temp	Strap on Sensor				2		Mechanical Room 220
Childcare DHW Recirc Pump Control	On/Off	1					Mechanical Room 220
Childcare DHW Recirc Pump Status	Amperage				1		Mechanical Room 220
Radiation Heating Valve(s)	2-10 VDC Control			21			Final Count to be Determined on Site
Space Temperature	Space Temp Sensor				21		Final Count to be Determined on Site
VAV Control	2-10 VDC Control			18			Final Count to be Determined on Site
VAV Discharge Temperature	Duct Sensor			18			Final Count to be Determined on Site

Our Lady of Fatima Points List							
CONTROL POINTS	DEVICE	DO	DI	AO	AI	Override Switch	Location
Outside Lighting Control	On/Off	1				1	Connect to contactor
Outside Light Sensor/Control	Light Sensor			2			North Outside Wall
Outside Air Temperature	Outside Air Sensor			1			North Outside Wall
Solenoid Trap Primer	On/Off	2					Refer to Plan

## **Division 26 Common Requirements for Electrical**

26 00 11	Electrical Specification Index
	<b>Common Contract Requirements for Electrical</b>
26 01 13	Electrical Supplemental Tender Form
26 01 15	Electrical Fees
26 01 16	Electrical General Requirements
26 01 17	Demolition and Renovation
26 01 20	Commissioning and Integrated Testing of Life Safety and Fire Protection System
	<b>Common Work Results for Electrical</b>
26 05 19	Wires and Cables
26 05 20	Splitters, 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>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>Interior Lighting</b>
26 51 13	Lighting Equipment
26 51 17	Digital Occupancy and Daylight Controls

## **Division 28 Electronic Safety and Security**

	<b>Fire Detection and Alarm</b>
28 31 24	Fire Alarm System (Conventional)

END OF SECTION

**PAGE INTENTIONALLY LEFT BLANK**

**Part 1          General**

**1.1                INSTRUCTIONS TO BIDDERS**

- .1      The Electrical Supplemental Tender Form must be submitted to the architect and consultant (dei@deiassociates.ca) within 2 hours of tender closing. Electrical contractors shall identify all sub-contractors he/she intends to use and must complete all information requested. The requisite information shall be given at the office of the Consultant. Contractor shall sign and date this page and initial and date each page thereafter.
- .2      Should the Electrical Supplemental Form not be submitted then the contractor shall use Basis of Design manufacturers as listed.
- .3      CONTRACTOR  
I/We certify that I/We have the authority to bind the company.

\_\_\_\_\_  
COMPANY NAME

\_\_\_\_\_  
AUTHORIZED SIGNATURE

\_\_\_\_\_  
ADDRESS

\_\_\_\_\_  
PRINTED SIGNATURE

\_\_\_\_\_  
CITY

\_\_\_\_\_  
TITLE

\_\_\_\_\_  
TELEPHONE NUMBER

\_\_\_\_\_  
DATE

\_\_\_\_\_  
FAX

CONTRACTOR'S NAME: \_\_\_\_\_

DATE: \_\_\_\_\_

4 SUB-CONTRACTORS

The Contractor shall state below the name of the Seismic Design Professional, Co-ordination Study, Life Safety Systems Commissioning Agent Sub-contractor he intends to use, which shall not be changed without the consent of the Consultant.

Seismic Design Professional \_\_\_\_\_

Co-ordination Study \_\_\_\_\_

Life Safety Systems Commissioning Agent \_\_\_\_\_

5 The Stipulated Bid Sum shall be for the basis of design manufacturer or supplier equipment only, unless otherwise indicated. Where a choice of this equipment is given, this Contractor shall indicate the supplier or manufacturer he intends to use. Where no choice is indicated, the basis of design supplier or equipment shall be used.

6 Equipment or materials manufactured by firms named in the following listing only shall be deemed equal to the equipment or material specified, provided the equipment or material will have capacity, performance, rating, construction, physical dimensions, accessories and features which, in the opinion of the Consultant, are equal to those of the specified equipment or material. The Electrical Contractor shall not indicate equipment, materials or suppliers which are not listed.

7 Where modifications to the work of other trades are required as a result or part of the alternative offered, include the cost of said modifications in the work.

8 Submit the following list of basis of design and alternative suppliers in accordance with the bid requirements:

Spec. Reference Section	Equipment	Basis of Design	Acceptable Alternate Manufacturer	Indicate Manufacturer Or Supplier
26 29 13.13	Starters and Contactors	Cutler Hammer	Allen Bradley Siemens Schneider Electric Klockner-Moeller GE Industrial	
26 05 75	Classroom Control Panels	Interspec	Wolf	
26 24 17	Molded Case Circuit Breakers	Cutler Hammer	Siemens Schneider Electric GE Industrial	
26 28 16	Disconnect Switches	Cutler Hammer	Siemens Schneider Electric GE Industrial	
26 24 16	Panelboards	Cutler Hammer	Siemens Schneider Electric GE Industrial	

CONTRACTOR'S NAME: \_\_\_\_\_

DATE: \_\_\_\_\_

26 28 13	Fuses – Low Voltage	Gould Shawmut	GEC Littlefuse	
26 51 13	LED Interior	Cooper	Lithonia Axis Philips Cree Vioneering	
26 43 13	Surge Protective Devices	Total Protection Solutions	Critec (Erico) Current Technologies Inc.	
26 51 13	LED Exterior	Lithonia	Sistemalux Cooper Indy Philips	
26 51 13	Exit Lighting	Beghelli	Emergilite Lumacell Stanpro Ready Lite Dualite Aimlite	
26 51 13	Emergency Battery Units	Beghelli	Emergilite Lumacell Stanpro Ready Lite Dualite Aimlite	
26 51 13	Emergency Fixtures	Beghelli	Emergilite Lumacell Stanpro Ready Lite Dualite Aimlite	
26 51 17	Digital Occupancy and Daylight Controls	Wattstopper	Sensor Switch Cooper Controls	
28 31 24	Fire Alarm System (Conventional)	Edwards(existing)		

CONTRACTOR'S NAME: \_\_\_\_\_ DATE: \_\_\_\_\_

.9 LABOUR RATES

.1 The following labour rates shall apply for calculating the cost of credit or extras on Change Notices. The rates shall include any employee benefits. The labour rates do not include overhead and profit.

Apprentice Electrician \$ \_\_\_\_\_/hr

Journeyman Electrician \$ \_\_\_\_\_/hr

**1.2 ELECTRICAL TENDER PRICE (EXCLUDING HST)**

.1 Having carefully examined all Drawings and Specifications and the Addenda to the Drawings and Specifications, and having carefully examined the sites and all conditions affecting the work, we, the undersigned thereby offer to provide all plant, labour, materials and incidentals required to complete the work of all trades for: All the work specified for herein for

the Total Stipulated Price of: \$ \_\_\_\_\_

\_\_\_\_\_  
(in writing)

in lawful money of Canada; included in which are all applicable excise taxes, custom duties, freight, exchange, and all other charges. HST is not included.

**END OF SECTION**

CONTRACTOR'S NAME: \_\_\_\_\_ DATE: \_\_\_\_\_

**Part 1            General**

**1.1                GENERAL INSTRUCTIONS**

- .1            Comply with the General Conditions, Supplementary Conditions, and all of General Requirements, Mechanical and Electrical Divisions.

**1.2                FEES**

- .1            The contractor is to include General inspection fees.

**END OF SECTION**

**PAGE INTENTIONALLY LEFT BLANK**

**Part 1            General**

**1.1                GENERAL**

- .1            This Section covers items common to Electrical Divisions.**
- .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                TENDERS**

- .1            Complete Supplemental Tender Form including list of equipment and materials to be used on this project and forming part of tender documents.
- .2            Submit Supplemental Tender Form as noted.
- .3            Submit tender based on specified described equipment or Alternates listed.
- .4            State in Tender, names of all Subcontractors proposed for work under this Division.

**1.4                LIABILITY INSURANCE**

- .1            This contractor must maintain and produce at the request of the consultant proof of proper insurance to fully protect the Owner, the Consultant and the Contractor from any and all claims due to accidents, misfortunes, acts of God, etc.

**1.5                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 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 co-ordinated 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.

#### **1.6 INTERFERENCE AND CO-ORDINATION 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 co-ordinated.
- .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.

#### **1.7 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.

## 1.8 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 Each bidder may elect to use “Alternate Equipment” from lists of Alternates where listed. Include for any additional costs to suit Alternated used. Prices are not required in Tender for Alternates listed except where specifically noted as “Separate Price”. Complete the Supplementary Tender Form.
- .3 It is 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.
- .4 If item of material specified is unobtainable, state in Tender proposed substitute and amount added or deducted for its use. Extra monies will not be paid for substitutions after Contract has been awarded.

## 1.9 EXAMINATION

- .1 Site Inspection
  - .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.

### 1.10 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. 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 effect these offsets, transitions, and changes in direction.

### 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 Security system rough-ins
  - .14 Voice/Data system rough-ins
  - .15 Classroom control panels
  - .16 Starters, contactors and control devices
  - .17 Wiring for mechanical equipment
  - .18 Wiring for owner's equipment
  - .19 Commissioning and Integrated System Testing**
  - .20 Electrical contractor closeout requirements (minimum of 3% but not less than \$5,000.00).
- .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 30 days after award of Contract.
  - .2 If material or equipment is not as specified or submittal is not complete, it will be rejected by Consultant.
  - .3 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.
  - .4 Partial submittals will not be accepted.**
  - .5 Catalog data or shop drawings for equipment, which are noted as being reviewed by Consultant or his Engineer shall not supersede Contract Documents.
  - .6 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. Check work described by catalog data with Contract Documents for deviations and errors.
  - .7 Check work described by catalog data with Contract Documents for deviations and errors.
  - .8 Shop drawings and product data shall show:
    - .1 Mounting arrangements.
    - .2 Operating and maintenance clearances. e.g. access door swing spaces.

- .9 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.
- .10 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.
- .11 Once these shop drawings are returned “reviewed” or “reviewed as noted” fabrication, production, and installation may commence. **NOTE: If a shop drawing is returned “reviewed as noted” this Contractor must provide written indication that the comments have been complied with.**

A partial list of shop drawings includes:

  - .1 Panelboards
  - .2 Surge protective devices
  - .3 Fire alarm system components
  - .4 Luminaires and drivers
  - .5 Emergency battery units and fixtures
  - .6 Classroom control panels
  - .7 Occupancy sensors and digital lighting controls (including completed engraving sheets)
  - .8 Starters, contactors and control devices
  - .9 Firestopping materials
  - .10 Hand dryers
  - .11 Wiring devices
  - .12 Cable management system
  - .13 Co-ordination study
  - .14 Roof cone
- .2 Submissions can be submitted via hard copy or electronically.
  - .1 Hard copy submissions:
    - .1 Submit 6 copies of data in 6 individual binders and index in same order and name as they appear in Specification. Prior to submission these shop drawings must be reviewed by the contractor and bear the “company stamp” of the contractor. If not stamped, the drawings will not be reviewed.
  - .2 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 3 copies of "reviewed" shop drawings and compile into maintenance manuals.

### 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 A submission has been made (if required by this size of project) by the consultant to the Electrical Safety Authority for review of this project. The payment of the required review costs will be co-ordinated by the consultant. A copy of the Electrical Safety Authority review report will be forwarded to the successful contractor for information and action.
- .2 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.
- .3 Reproduce drawings and specifications required by Electrical Safety Authority at no cost.
- .4 Notify Consultant of changes required by Electrical Safety Authority prior to making changes.
- .5 Furnish Certificates of Acceptance to Engineer from Electrical Safety Authority and other authorities having jurisdiction upon completion of work.
- .6 This contractor must furnish any certificates required to indicate that the work completed conforms with laws and regulations of authorities having jurisdiction.

### **1.16 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.

### **1.17 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.

### **1.18 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.

### **1.19 EQUIPMENT IDENTIFICATION**

- .1 Identify electrical equipment with nameplates as follows:
- .2 Nameplates:
  - .1 Lamicoïd 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.

**1.20 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.

**1.21 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
Voice/Data System	orange
Security	brown
Fire alarm	red
Emergency lighting	pink
- .4 This contractor must paint all system junction boxes and covers in conformance with the above schedule.

**1.22 PROTECTION OF OPENINGS**

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

### 1.23 WIRING TERMINATIONS

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

### 1.24 MANUFACTURERS AND CSA LABELS

- .1 All labels must be visible and legible after equipment is installed.

### 1.25 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").

### 1.26 LOCATION OF OUTLETS

- .1 Do not install outlets back-to-back in wall; allow minimum 150 mm (6") horizontal clearance between boxes.
- .2 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.

### 1.27 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 (42").
  - .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: 1100 mm (42").
  - .6 Fire alarm visual and signal devices: 2250 mm (88 ½").
  - .7 Thermostat: 1200 mm (3'-11").
  - .8 Emergency call switches and/or pushbuttons: 900 mm (36").

### 1.28 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.

### **1.29 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.

### **1.30 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.

### **1.31 CO-ORDINATION 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 co-ordination study.

### **1.32 GUARANTEE AND WARRANTY**

- .1 At the substantial completion stage 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 substantial completion 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 substantial completion.

### **1.33 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, consultant, contractor, and manufacturer's representative. Each person shall witness and sign off each piece of equipment.
- .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.

### **1.34 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. Make changes as requested and re-submit as directed by Consultant.
- .3 Submit one manual for approval (three manuals will be required at project completion). Each of which shall be a three ring binder (minimum 50 mm (2") ring) labelled:
  - .1 Operation and Maintenance Manual.
  - .2 Project Name.
  - .3 Location.
- .4 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 One year warranty letter 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 Receipt of spare fuses from owner's representative.
  - .8 Receipt of turned over keys for electrical panels.
  - .9 Final certificate from the Electrical Safety Authority.

- .10 Final Fire alarm verification certificate and field technician device sheets.
  - .11 Certificate of exit/emergency lighting testing as per the specification.
  - .12 Copy of electrical shop drawings which have been stamped and reviewed by Consultant
  - .13 Coordination study shop drawings.
  - .14 Any special warranties on equipment required (i.e. LED lighting and digital control).
  - .15 Copy of stamped letter from Seismic design professional.
  - .16 Lighting System commissioning certificate and report.
  - .17 Integrated life safety system commissioning certificate and report.
- .5 Upon acceptance of Operation and Maintenance Manual by the consultant, a pdf file on the entire manual is to be provided on a USB stick. Only one USB stick is to be provided containing both the approved manuals and record drawings.

### 1.35 RECORD 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 Record drawings:
  - .1 Identify each drawing in lower right hand corner in letters at least 3 mm (1/8") high as follows: - "RECORD 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 record drawings as well as a scanned pdf file copy on USB stick with Operating and Maintenance Manuals.
- .3 The contractor will include in his tender \$50.00 for each and every electrical drawing for DEI & Associates Inc. to CAD the Record drawings. The CAD drawings files will be provided to the owner as part of the maintenance manuals.

### 1.36 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, Record 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.

### **1.37 SUBSTANTIAL PERFORMANCE**

- .1 Complete the following to the satisfaction of the consultant prior to submission of substantial performance.
  - .1 Record Drawings.
  - .2 Maintenance Manuals.
  - .3 System Start up.
  - .4 Instructions to Owners.  
Final Certificates (Electrical Safety Authority, Fire Alarm, Emergency Lighting, Integrated Life Safety Systems Commissioning, Electrical Seismic Restraint Engineers' Letter).

### **1.38 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.

### **1.39 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.

### **1.40 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.

### **1.41 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.

#### 1.42 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. Provide "firewrap" blanket around services penetrating firewalls.
- .5 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 Fyresleeve Industries Inc.
  - .2 General Electric Pensil Firestop Systems
  - .3 International Protective Coatings Corp.

- .4 Rectorseal Corporation (Metacaulk)
- .5 Proset Systems
- .6 3M
- .7 AD Systems
- .8 Hilti
- .9 Royal

**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 substantial completion.

#### **1.43 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.

#### **1.44 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.

**1.45 DELIVERY STORAGE & HANDLING**

- .1 Follow Manufacturer's directions in delivery, storage, and protection, of equipment and materials.
- .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.

**1.46 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.

**1.47 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.

**1.48 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.

**1.49 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.

**1.50 OWNER SUPPLIED EQUIPMENT**

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

**1.51 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.

**1.52 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 walls 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.

**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 is one of a retrofit nature in part, and which will require extensive 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.
- .2       The reference drawings indicate some of the services which shall remain and some may have to be retained through construction and a phased changeover to help construction i.e. electrical service, phone service, winter heat, and temporary construction services i.e. washroom facility. This co-ordination remains the responsibility of the contractors.

**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.

**END OF SECTION**

February 2017

---

**Part 1            General**

**1.1                INTENT**

- .1    Life safety and fire protection systems are to be installed to comply with the provisions of the current Ontario Building and Fire Codes. As a result, commissioning of these integrated systems must be performed as a whole to ensure the proper operation and inter-relationship between systems.
- .2    The commissioning is to provide functional verification and documented confirmation that these building systems satisfy the intent of the Building Code.
- .3    These systems as applicable to any given project include but are not limited to fire alarm, sprinkler system and associated valves, standpipe, smoke control, ventilation, and pressurization systems, door hold open devices, elevator recalls, smoke, fire shutters, and dampers, emergency power generator, fire pump assemblies, and emergency lighting.

**1.2                GENERAL**

- .1    This commissioning process is the responsibility of the electrical sub-contractor.
- .2    This process must be co-ordinated with suppliers and sub-contractors associated with these systems (mechanical and/or electrical).
- .3    This process must be co-ordinated with the project construction schedule and be completed, including all associated documentation, prior to the consultant's certification of the project for occupancy.
- .4    All applicable contractors, sub-contractors, and suppliers are to include all required costs in their respective tender costs.
- .5    All work is to be performed in accordance with CAN/ULC S1001 2011 Edition. Sequence of Operation Form required to be completed in conjunction with the Life Safety Systems Commissioning Agent (LSSCA) and submitted to the consultant's prior to occupancy.

**1.3                QUALITY ASSURANCE**

- .1    The following criteria must be met in order to be considered an acceptable commissioning sub-contractor for this project:
  - .1    Manufacturers: Firms regularly engaged in functional testing and implementation of life safety and fire protection systems for not less than five years.
  - .2    Qualifications: Firms with at least five years of successful experience in facility construction, inspection, acceptance testing or commissioning as it relates to fire protection and life safety and equipment similar to that required for this project.
  - .3    The Contractor shall be an established commissioning contractor that has had and currently maintains a locally run and operated business for at least five years.
  - .4    The Contractor shall show satisfactory evidence, upon request, that he maintains a fully equipped service organization capable of furnishing adequate inspection and service to the systems.

February 2017

---

- .2 Pre-qualified Life Safety Systems Commissioning Agents include these listed below or local branches of the companies noted in the vicinity of this project:
- .1 Brosz Technical Services Inc.  
64 Bullock Dr.  
Markham, Ontario  
L3P 3P2  
Contact: Mr. Peter Brosz  
(Tel) 905- 472-6660 or Toll Free 1-877-472-7670  
(Email): pbrosz@brosz.net
  - .2 Richardson Fire Systems  
13 Old Mill Road  
Cambridge, Ontario  
N3H 4R8  
(Tel): 519-650-8057
  - .3 Chubb Edwards  
560 Parkside Drive, Unit 401  
Waterloo, Ontario  
Contact: Mr. Mike LeBlanc  
(Tel) 519-746-4667 Ext 824226  
(Cell) 226-750-5578  
(Email) mike.leblanc@chubbedwards.com
  - .4 Georgian Bay Fire and Safety Ltd.  
1700 20th Street East  
Owen Sound, Ontario  
Contact: Mr. Ed Robertson/ Mr. Steve Salese  
(Tel) 519-376-6120/(Tel) 519-496-4369  
(Email): erobertson@gbfire.com/ ssalese@gbfire.com
  - .5 Vintage Fire and Life Safety Ltd.  
25 Coverdale Cres.  
Kitchener, Ontario N2M 4X1  
Contact: Mr. Mark Vintage  
(Tel): 226-220-9646  
(Email): mark@vintagefireandlifesafety.com
  - .6 Troy Life and Fire Safety  
805 Boxwood Dr., Unit #201  
Cambridge, Ontario N3E 1A4  
Contact: Mr. Lou Raposo/Mr. Jason Rowland  
(Tel): 519-650-0600 Ext. 241/519-650-0600 Ext. 232  
(Cell): 226-792-0594/519-502-5505  
(Email): [lou.raposo@troylfs.com](mailto:lou.raposo@troylfs.com)/[jason.rowland@troylfs.com](mailto:jason.rowland@troylfs.com)

February 2017

---

- .7 Control Tech Systems  
31 Regal Road  
Guelph, Ontario N1K 1B6  
Contact: Mr. Richard Giguere  
(Tel): 519-519-826-9229  
(Cell): 519-826-1155  
(Email): richard@controltechsystems.ca

**NOTE: This agent must be a third party firm NOT associated with this project in any way and be under contract with the electrical sub-contractor not the fire alarm supplier.**

- .3 Other contractors to these listed above, who feel they are capable, must submit in writing, to the Consultant's office confirmation of the items listed in the criteria above, a minimum of one week prior to tender close in order to be considered as a bidder.

#### 1.4 GENERAL REQUIREMENTS

- .1 The Commissioning Process shall encompass and co-ordinate the following areas:
  - .1 System documentation.
  - .2 System start-up and Performance Testing (Functional Testing).

#### 1.5 RESPONSIBILITIES

- .1 General Contractor:
  - .1 The general contractor shall verify completeness of the building envelope, perimeter and interior items which affect proper operation of the noted systems.
  - .2 The general contractor will assure participation and co-operation of Sub-Contractors and Specialty Contractors (mechanical, electrical, building management, etc.) under the General Contractor's jurisdiction as required for the commissioning process.
- .2 Mechanical Contractor:
  - .1 Verify Functional performance of associated mechanical systems for compliance with design intent as specified in the appropriate Specification sections.
  - .2 Provide the documentation with standard Functional performance reports on completion of the testing.
  - .3 Verify submissions for system operation and maintenance manuals, as-built (record) documents, spare parts listing, special tools listing, and other items as may be specified.
- .3 Electrical Contractor:
  - .1 The Life Safety Systems Commissioning Agent (LSSCA) is being retained by the electrical contractor, however; this contractor's work to satisfy the LSSCA requirements shall be included in the tender price.
  - .2 Verify Functional performance of electrical systems for compliance with design intent as specified in the appropriate Specification sections.
  - .3 Provide the documentation with standard Functional performance reports on completion of the testing.

February 2017

---

- .4 Verify submissions for electrical system operation and maintenance manuals, record documents, spare parts listing, special tools listing, and other items as may be specified.
- .5 As a minimum this contractor must include for:
  - .1 Providing the LSSCA with documentation of design and shop drawings.
  - .2 Provide documents for sequence of operation and maintenance of system.
  - .3 Testing of all components and accessories to confirm Alarm/Supervisory/Trouble at the fire panel.
  - .4 Testing and operation of any generator (s) as applicable to the project.
  - .5 Other items that may be requested by the LSSCA.
  - .6 Re-commissioning of any items that may have failed.
  - .7 Re-setting of the system to proper operation after tests are completed.
- .4 Equipment Manufacturers:
  - .1 The equipment manufacturers shall be responsible for providing labour, material, equipment, etc., required within the scope of the respective equipment to facilitate the commissioning process.
  - .2 The equipment manufacturers will perform Pre-Functional and Functional Performance Tests required by the commissioning process.
- .5 Design Engineer:
  - .1 The design engineer shall observe Functional Performance Testing, at his discretion.
  - .2 The design engineer shall provide technical capabilities for resolution of deficiencies, where required.

## **Part 2 Commissioning Process**

### **2.1 OPERATIONS AND MAINTENANCE MANUALS**

- .1 Furnish Final, reviewed Operation and Maintenance Manuals to the Consultant fourteen (14) days prior to scheduled Functional Performance Tests.

### **2.2 FUNCTIONAL PERFORMANCE TEST**

- .1 The contractor shall be responsible for the Functional Performance Tests. These tests ensure that all equipment and systems are installed in accordance with the Specifications, Drawings and manufacturers' requirements.
- .2 The contractor shall be responsible for co-ordinating schedule for Functional tests of various equipment and systems.
- .3 In the Functional Test, all noted systems and sub-systems shall be checked for the following:
  - .1 Verify that each element has been properly installed, properly identified, and that all connections have been made correctly.
  - .2 Verify that tests, meter readings, and specific mechanical/electrical performance characteristics agree with those required by equipment or system manufacturer.

- .3 Re-commission any item (s) that may have failed.
- .4 Notify the consultant in writing, at least fourteen (14) days prior to the date of Functional Performance Testing. Schedule the Functional performance tests over a period of consecutive business days.

**END OF SECTION**

**PAGE INTENTIONALLY LEFT BLANK**

**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.

**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 MINERAL INSULATED CABLES**

- .1 Run cable exposed, securely supported by straps and hangers.
- .2 Support 2 h fire rated cables at 1 m (39") intervals.
- .3 Make cable terminations by using factory-made kits.
- .4 At cable terminations use thermoplastic sleeving over bare conductors.
- .5 Where cables are buried in cast concrete or masonry sleeve for entry and exit of cables.
- .6 Do not splice cables.

**3.4 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            Splitters must conform to CSA C22.2 No. 76 (latest edition).
- .2            Junction and pull boxes must conform to CSA C22.2 No. 40 (latest edition)

**2.2                SPLITTERS**

- .1            Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .2            Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.
- .3            At least three spare terminals on each set of lugs in splitters less than 400 A.
- .4            Splitter length must match arrangement of equipment unless indicated otherwise.

**2.3                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                SPLITTER INSTALLATION**

- .1            Install splitters and mount plumb, true and square to the building lines on 19 mm (3/4") painted plywood backboards.

**3.2                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.

**3.3                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**

**PAGE INTENTIONALLY LEFT BLANK**

**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        347 V outlet boxes for 347 V switching devices.
- .6        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                FLOOR BOXES**

- .1        Flush floor boxes where indicated shall be complete with the following features:
  - .1        Four (4) independent wiring compartments.
  - .2        Flexible activation cover.
  - .3        Fully adjustable.

- .4 Sixteen (16) Kos 12.7 mm (½ ") – 32 mm (1 ¼ ").
- .5 Stamped steel construction (concrete-tight).
- .2 Manufacturers:
  - .1 Wiremold Cat# RFB4-DTB-2-2T-RAKM11- flush floor box complete with two duplex receptacle brackets, 2 dual RJ brackets, and recessed activation with carpet trim plate.  
Approved alternates:
    - .1 Hubbell Cat. #LCFBSS complete with LCFB XX (colour by architect), flush cover and internal faceplate to suit devices noted on the drawings.
    - .2 Wellmark Electric Inc. Cat. #400B-1-YY-XX-CRL.

## 2.6 CONDUIT BOXES

- .1 Cast FS or FD ferrous alloy 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 OUTLET BOXES FOR NON-METALLIC SHEATHED CABLE

- .1 Electro-galvanized, sectional, screw ganging steel boxes, minimum size 76 mm 50 mm x 63 mm (3" x 2" x 2-1/2") with two double clamps to take non-metallic sheathed cables.

## 2.8 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**

**PAGE INTENTIONALLY LEFT BLANK**

**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            Clamps for grounding of conductor: size as required to electrically conductive underground water pipe.
- .2            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.
- .3            Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.
- .4            Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
  - .1            Grounding and bonding bushings.
  - .2            Protective type clamps.
  - .3            Bolted type conductor connectors.
  - .4            Bonding jumpers, straps.
  - .5            Pressure wire 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: frames of motors, starters, control panels, elevators, distribution panels, and outdoor lighting.

**3.3 COMMUNICATION SYSTEMS**

- .1 Install grounding connections for telephone, sound, fire alarm, computer network systems as follows:
  - .1 Communications system 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                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.

**1.2                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).

**1.3                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.

**1.4                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.

### **1.5 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.

### **1.6 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.

### **1.7 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.

### **1.8 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).

## 1.9 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 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.

## 1.10 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 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.

### **1.11 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.

### **1.12 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. **WRITER TO CONFIRM**

### **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**

**PAGE INTENTIONALLY LEFT BLANK**

**Part 1            General**

**1.1                REFERENCES**

- .1 Canadian Standards Association (CSA)
  - .1 CAN/CSA C22.2 No.18-92, Outlet Boxes, Conduit Boxes, and Fittings.
  - .2 CSA C22.2 No.45-M1981(R1992), Rigid Metal Conduit.
  - .3 CSA C22.2 No.56-1977(R1977), Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .4 CSA C22.2 No.83-M1985(R1992), Electrical Metallic Tubing.
  - .5 CSA C22.2 No.211.2-M1984(R1992), Rigid PVC (Unplasticized) Conduit.
  - .6 CAN/CSA C22.2 No.227.3-M91, Flexible Nonmetallic Tubing.

**Part 2            Products**

**2.1                CONDUITS**

- .1 Rigid metal conduit: to CSA C22.2 No.45, aluminum threaded.
- .2 Epoxy coated conduit: to CSA C22.2 No.45, with zinc coating and corrosion resistant epoxy finish inside and outside.
- .3 Electrical metallic tubing (EMT) with couplings: to CSA C22.2 No.83.
- .4 Rigid PVC conduit: to CSA C22.2 No.211.2.
- .5 Flexible metal conduit: to CSA C22.2 No.56, aluminum and liquid-tight flexible metal.
- .6 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. Where devices are to be installed on existing walls in finished area, which cannot be "fished", install feeds in a surface metal raceway equal to Wiremold V700 series. Co-ordinate surface installations with consultant prior to rough-in.
- .3 **Use electrical metallic tubing (EMT) for all branch circuits unless specified otherwise.**
- .4 Use rigid aluminum threaded conduit where specified and up to 2.1 m (7'0") above finish floor where exposed to mechanical injury.
- .5 Use rigid PVC conduit underground and in kitchen areas.
- .6 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.
- .7 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.
- .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 Run 2- 27 mm (1") spare conduits up to accessible ceiling space from each flush panel. Terminate these conduits in 152 mm x 152 mm x 102 mm (6" x 6" x 4") junction boxes in ceiling space.
- .14 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- .15 Dry conduits out before installing wire.
- .16 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.

### 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 larger than 25 mm (1") 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**

**PAGE INTENTIONALLY LEFT BLANK**

**Part 1            General**

**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. 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.

**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 addendum's 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 When emergency generator is provided, include phase and ground coordination of the generator protective devices. Show the generator decrement curve and damage curve along with the operating characteristic of the protective devices. Contractor shall obtain the information from the generator manufacturer and include the generator actual impedance value, time constants and current boost data in the study. Do not use typical values for the generator.
  - .11 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.

- .12 For motor control circuits, show the MCC full-load current plus symmetrical and asymmetrical of the largest motor starting current and time to ensure protective devices will not trip during major or group start operation.

## **2.2 STUDY REPORT**

- .1 The results of the power system study shall be summarized in a final report. Six (6) bound copies of the final report must be submitted.
- .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 Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
  - .4 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.

### **3.3 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**

**PAGE INTENTIONALLY LEFT BLANK**

**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        Telecommunication network system rough-in.
  - .4        Classroom control panels.
  - .5        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        Surface mounting.
  - .2        Fixed nozzle.
  - .3        White finish with automatic activation.
  - .4        Rating of 1800 W (20 A) at 120 V.
  - .5        NOVA 4-0412
  - .6        Approved alternate:
    - .1        World Dryer Cat. #XA5-2-974.

**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:  
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 c/w 12 CTR HGR  
Intralec 1200 Cardiff Blvd., Mississauga, ON L5S 1P6 Tel: 905-670-0970

### 2.3 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 Rough-ins shall also be provided for public address and security systems as indicated.

### 2.4 CLASSROOM CONTROL PANELS

- .1 Provide surface mounted ClassMate Classroom Control Panels as detailed on the drawings. To be specified as manufactured by Interspec Systems Limited. – Rosemont, ON (705) 435-3780 x.21 Specified manufacturer's products establish minimum standards and shall be base bid.
- .2 Modular control panels shall be constructed of structurally sound 6063 T5 alloy satin anodized aluminum frame .080 mm thick with high pressure plastic laminate faced panels of lightweight particle core and 0.50 mm thick plastic laminate backing sheet. Plastic laminate colour as selected by the Architect from Arborite or Formica, furniture finish, from manufacturer's standard colour range. Complete assembly to meet flame spread ratings in areas used.

- .3 Units to be complete with backboxes fabricated from heavy guage satin coat steel with suitable barriers and continuous knockouts. Satin anodized faceplates shall be pre-punched to accept detailed components.
- .4 All panels shall be vandal resistant and removable with special tools for service access.
- .5 Fabricate units in accordance with reviewed shop drawings with extruded aluminum frames and solid plastic laminated face panels.
- .6 Panels to be removable from aluminum frames with rounded profile edging.
- .7 Front panels to have colour finish as selected by the Architect.
- .8 Panels to have all openings, mounting hardware, etc. for services as required for installation of mechanical and electrical services.
- .9 Units to be full height from 200 mm off floor to underside of ceiling panels.
- .10 Part numbers:  
CCP-3016-04JV – ClassMate 406 mm (16”) Wide x 102 mm (4”) Deep
- .11 Acceptable equal is as follows:  
Wolfe Architectural Works  
587 Hanlan Road,  
Woodbridge, Ontario  
Canada L4L 4R8  
Tel: 905-266-1010  
Fax: 905- 266 1015  
M: 416-458-8895  
info@wolfeworks.ca

## 2.5 OCCUPANCY SENSORS

- .1 Where noted on the drawings the ceiling mounted occupancy sensor shall be either:
  - .1 Wattstopper Cat. #DT-300 c/w BZ-50 power pack.
  - .2 Sensor switch Cat. #CMPDT 10RP c/w PP-20 power pack.
  - .3 Greengate Cat. #OAC-DT-2000R c/w SP20-MV power pack.
- .2 Where noted on drawings the wall mounted (passive technology) occupancy sensor used in storage and service rooms shall be either:
  - .1 Wattstopper Cat. #PW-100-VOLT-X (colour by architect).
  - .2 Sensor switch Cat. #WSD-VOLT-X (colour by architect).
  - .3 Greengate Cat. #ONW-P-1001-VOLT-X (colour by architect).
- .3 Where noted on the drawings, the wall mounted switch style occupancy sensor used in Administrative Offices and Seminar/Meeting Rooms shall be a dual technology switch with either single or double relay (circuit) as noted on the drawings. Colour to suit architect.

Note: For dual relay switches, program the sensor for 15 minute off delay, enabled walk-thru, audible alert enabled, relay 1 on mode: auto on, relay 2 on mode: manual on.

- .1 Single relay (circuit): Wattstopper Cat. #DW-100
- .2 Dual relay (circuit): Wattstopper Cat. #DW-200
- .3 Approved equal:
  - .1 Greengate.
  - .2 Sensor switch.
- .4 Provide other occupancy sensors to suit the detail on the drawings.
- .5 All sensors shall be set to 5 minutes "delay to off" unless otherwise directed.

### **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 white 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 TELECOMMUNICATION NETWORK SYSTEM ROUGH-IN**

- .1 Provide backboard as noted complete with ground connection to main service ground.
- .2 Conduits terminated into ceiling spaces must be within 3m (10') of zone conduits (if applicable).
- .3 Ensure specified zone conduits are installed back to service backboard.
- .4 Outlets are to be installed complete with 25 mm (1") conduit to corridor ceiling space or nearest zone conduit (if applicable).
- .5 Provide insulated bushings on all conduits terminated in ceiling space.
- .6 A 25mm (1") conduit is to be installed from elevator machine room to voice service backboard.

### **3.4 CLASSROOM CONTROL PANELS**

- .1 Division 16 to supply and install units in accordance with manufacturers' recommendations and reviewed shop drawings complete with all frames, cutouts, face panels, etc., to provide a complete installation.
- .2 It is Division 16's responsibility to coordinate complete installation of all mechanical, electrical and miscellaneous services in all control panels. Components within control panels will vary from room to room.

### **3.5 OCCUPANCY SENSORS**

- .1 Install power packs in accessible maintenance areas.
- .2 Provide access doors if power packs are installed above drywall ceilings.
- .3 It shall be the contractor's responsibility to locate and aim sensory 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.
- .4 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.
- .5 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.
- .6 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.

**END OF SECTION**

**PAGE INTENTIONALLY LEFT BLANK**

**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 or switch 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.**
- .5        Bus and breakers/switches must be rated for 10,000 A (symmetrical) interrupting capacity or 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        Cutler Hammer CAT. # POW-R-LINE-C PRL-1 or PRL-2,
  - .2        Schneider Electric CAT# NQ Series
  - .3        Siemens CAT #Sentron P1 Series
  - .4        GE Industrial Cat. # AQ Series (120/208V)
- .15       Power distribution circuit breaker panelboards (400 AMP or larger) must be one of the following:
  - .1        Cutler Hammer 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)
- .5 GE Industrial Cat. # Spectra Series (Bolt-On)

## 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 (if 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.
- .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.

**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 I<sup>2</sup>t 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 I<sup>2</sup>t 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       Transformer feeder for the units 225kVA and above: LSI or LS trip unit with fixed instantaneous over-ride, where instantaneous trip setting or instantaneous over-ride allows for transformer inrush of 12xFLA at 0.1s and exceeds maximum value of fault at the transformer secondary.
    - .3       Feeders exceeding 250A trip setting: LS trip unit with fixed instantaneous over-ride exceeding maximum value of fault at downstream panelboard.

- .4 Branch circuits or feeders for MCCs with fusible combination starters:  
LSI trip unit where instantaneous trip setting allows for maximum size  
downstream fuse total clearing time.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install circuit breakers as indicated complete with all necessary mounting hardware and  
filler panels if necessary.

**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        General purpose AC switches must conform to CSA C22.2 No. 111 (latest edition).
- .2        15 or 20 A, 120 V, single pole, double pole, three-way, four-way, keyed, or motor rated switches complete with pilot light.
- .3        Manually-operated general purpose ac switches with following features:
  - .1        Terminal holes approved for No. 10 AWG wire.
  - .2        Silver alloy contacts.
  - .3        Urea or melamine molding for parts subject to carbon tracking.
  - .4        Suitable for back and side wiring.
  - .5        Toggle style (Rocker style) (architect to select colour).
- .4        Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
- .5        Switches of one manufacturer throughout project.
- .6        Acceptable materials:
  - single pole:    Hubbell Cat # HBL1201 Series
  - three way:    Hubbell Cat # HBL1203 Series
  - four way:     Hubbell Cat # HBL1204 Series
  - Keyed:        Hubbell Cat. #HBL1221 Series complete with 2 keys per switch
  - (Keys):       Hubbell Cat. #HBL1209
  - Motor rated:  Hubbell Cat. #HBL1221PL c/w pilot light (20 A):
- .7        Acceptable 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:

Standard duplex receptacle	Hubbell Cat # HBL5252CN
Ground fault protected T-slot receptacles	Hubbell Cat. # GF20L A complete with Decora style coverplate to suit specification below
T-slot receptacles	Hubbell Cat. #HBL5352
Dryer receptacle	Hubbell Cat # HBL9430A
Range receptacle	Hubbell Cat # HBL9450A
Tamper resistant receptacle	Hubbell Cat # BR15TR
Tamper resistant T-slot receptacle	Hubbell Cat. #BR20TR
Tamper resistant ground fault protected receptacle	Hubbell Cat. #GFTR15
Tamper resistant ground fault protected T-slot receptacle	Hubbell Cat. #GFTR20 complete with Decora style coverplate to suit specification below

- .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.

**2.4 DIMMER CONTROL**

- .1 Dimmers are to be provided complete with the following features:
  - .1 120 V, 0 – 10V type compatible with controlled fixtures.
  - .2 Wattage to suit load as indicated on drawings (minimum 300W).
  - .3 Thin profile linear slide control only. (Rotary controls will not be accepted).
  - .4 Dimmer must provide full range of illumination from zero to full intensity.
  - .5 Integral on/off switch.

- .6 Devices must mount in single gang box or multi-ganged where noted.
- .7 Device and faceplate colour must match other wiring devices.
- .8 Acceptable manufacturers:
  - .1 Leviton Renoir II Series
  - .2 Lutron Diva Series

### **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 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.
- .4 Dimmer:
  - .1 Mount devices at height as specified in Electrical General Requirements Section.
  - .2 Dimmer switches must be installed with the "most downward" position of slider corresponding to zero light intensity and the "highest" position of slider corresponding to full light intensity.

**END OF SECTION**

**PAGE INTENTIONALLY LEFT BLANK**

**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.
- .10      Disconnects feeding elevator controllers must be equipped with two auxiliary contacts approved by the elevator supplier.

**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>
Cutler Hammer	IHD Series	3HD Series
Schneider Electric	Type A Series	Type R Series
Siemens	ID Series	NFR/FR Series
GE Industrial	TH Series	TH Series

**Part 3          Execution**

**3.1            INSTALLATION**

- .1          Install disconnect switches complete with fuses if applicable.
- .2          Connect auxiliary contacts to elevator controller using conduit, wire and route approved by the elevator supplier.

**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 and IEC starters will not be accepted.

## 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 3 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 2 normally open and 2 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 Cutler Hammer
  - .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**

**PAGE INTENTIONALLY LEFT BLANK**

**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 C62.41 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:
  - Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11, C62.41, C62.45)
  - American National Standards Institute
  - National Electrical Manufacturer Association (NEMA LS-1 1992 Peak Current Testing)
  - Electrical and Electronic Mfg. Association of Canada (EEMAC)
  - National Fire Protection Association (NFPA 75 and 780)
  - MIL Standard 220A Method of Insertion Loss Measurement
  - Ontario Electrical Code
  - Underwriters Laboratories UL 1283 and UL 1449 (3rd edition)
  - 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.
- .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 thirty (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 (3rd edition, latest revision), 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 basis of design shall be Total Protection Solutions Canada, as provided by Innosys Power Inc. (Contact Monica Johnston, Ph: 519-505-4862). Alternates as listed on Supplemental Tender Form only. Alternates must also include on site visit to approve installation of SPD's by manufacturer representative as noted in this specification.

**2.2 DISTRIBUTION PANEL AND MOTOR CONTROL CENTER 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 Third Ed. Type 1 for use in Type 1 and Type 2 locations.
- .2 Distribution Panels and MCCs shall be protected by an externally mounted SPD, model TK-ST200-3Y600-L for 600 (4W+G) volt panels, and model TK-ST160-3Y208-L or TK-ST080-3Y208-L for 120/208 (4W+G) volt panels noted for 160 KA/Phase and 80 KA/Phase respectively.
- .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 contaminates 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. SPD's shall be certified to UL1283 and UL1449 Third Ed. 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 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 contaminates 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 Because of space limitation, 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.
- .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, branch panel, and motor control center units 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 (ANSI)
  - .1 ANSI C82.1-1995, Specifications For Fluorescent Lamp Ballasts.
  - .2 ANSI C82.4-1992, Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps.
- .2 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.
- .3 American Society for Testing and Materials (ASTM)
  - .1 ASTM F1137- 88 (1993), Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.
- .4 United States of America, Federal Communications Commission (FCC)
  - .1 FCC (CFR47) EM and RF Interference Suppression.
- .5 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 shall be as follows from date of substantial completion.
  - .1 LED fixtures, and driver: 5 years.
- .2 The labour required to replace these ballasts, lamps or drivers must be included in the above guarantee.

**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%.

**2.2                FIXTURE LENS**

- .1        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.

**2.3                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.

**2.4                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.

**2.5 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 (3) pictogram legends indicating “left from here”, “straight from here”, and “right from here”.
- .7 Face plate to remain captive for relamping.
- .8 Supply voltage; 120 V, AC.
- .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.

**2.6 EMERGENCY LIGHTING UNITS**

- .1 Emergency lighting units must conform to CSA C22.2 No 141 (latest edition).
- .2 Supply voltage: 120 V, AC.
- .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.

## 2.7 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.

## 2.8 ACCEPTABLE LIGHTING MANUFACTURERS

- .1 Acceptable manufacturers as listed on Supplemental Tender Form and Light Fixture Schedules.

## 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. Coordinate 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 900mm (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 300mm (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 lamicoïd 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)
- .2 **Provide "Integrated Testing" of this life safety system in conformance with the noted specification section. Include all associated costs in tender.**

**END OF SECTION**

**PAGE INTENTIONALLY LEFT BLANK**

**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.
- .4     Include engraving sheets for all digital switch configurations with shop drawings. Complete engraving sheets with labels for consultant approval according to design details.

**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 15 for Low Voltage Relay Lighting Control System information (central areas and exterior).
- .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 relays controllers.

- .2 Digital Room Plug Load Controllers – Self-configuring, digitally addressable single relay application specific plug load controllers.
- .3 Digital Occupancy Sensors – Self-configuring, digitally addressable and calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
- .4 Digital Switches – Self-configuring, digitally addressable pushbutton switches, dimmers, and scene switches with two-way active infrared (IR) communications.
- .5 Digital Photosensors – Single-zone closed loop sensors with two-way active infrared (IR) communications can provide switching or dimming control for daylight harvesting.
- .6 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.
  - .4 Plug Loads – Provide automatic shut off of designated plug loads in enclosed and open office spaces as noted on floor plans and lighting control sequence. Provide interconnection of plug load controller to central low voltage lighting control system.

## 1.6 WARRANTY

- .1 Provide a five year complete manufacturer's warranty on all products to be free of manufacturers' defects.

## 1.7 QUALITY ASSURANCE

- .1 Manufacturer: Minimum 10years experience in manufacture of lighting controls.

**Part 2 Products**

**2.1 MANUFACTURERS**

- .1 Basis of design product: WattStopper Digital Lighting Management (DLM). Equal as manufactured by one of the following:
  - .1 Cooper Controls (Greengate) Cat. #Greengate Room Controller
  - .2 Sensor Switch Cat. #nLight Series.

**2.2 SINGLE / DUAL RELAY WALL SWITCH OCCUPANCY SENSORS**

- .1 Type DW: Manual-ON, Automatic-OFF dual technology (passive infrared and ultrasonic) wall switch occupancy sensor. Furnish the Company's model which suits the electrical system parameters, and accommodates the square-foot coverage and wattage requirement for each area (and type of lighting) controlled; WattStopper DW-100, DW-200, DW-103, DW-203.

**2.3 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

## 2.4 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. **Refer to wall switch configuration details on design drawings.**
- .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 **Digital wallstations shall be programmed with single state operation for each button as detailed on plans.**
- .6 WattStopper product numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101.

## 2.5 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, LRMC-212, LRMC-213, LMPL-201, LMRC-311, LMRC-312, LMRC-313.

## 2.6 DIGITAL PHOTOSENSORS

- .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.

## 2.7 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.

## 2.8 CONFIGURATIONS TOOLS

- .1 A configuration tool facilitates optional customization of digital lighting control system featuring infrared communications.
- .2 Features and functionality of the wireless configuration tool shall include:
  - .1 Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet.
  - .2 Read, modify and send parameters for occupancy sensors, daylighting sensors, room controllers and buttons on digital wall switches.
  - .3 Save up to nine occupancy sensor setting profiles, and apply profiles to selected sensors.
- .3 WattStopper Product Numbers: LMCT-100, LMCI-100/LMCS-100

## 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 Install sensors in gym where noted at height per manufacturer's recommendations.
- .6 It shall be the contractor's responsibility to locate and aim sensory 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.

- .7 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.)
- .8 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 ASHRAE 9.4.4. This cost shall be included in the Tender Price.
- .5 Include for the following manufacturer representative visits to site:
  - .1 Pre-wiring visit.
  - .2 System set-up visit.
  - .3 Third party ASHRAE functional testing visit.
  - .4 System commissioning visit.

### **3.3 INTEGRATED TESTING**

- .1 Provide “integrated testing” for the life safety portion of this system in conformance with the noted specification section. Include all associated costs in tender.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES**

- .1        CAN/ULC-S524 (latest edition), Installation of Fire Alarm Systems.
- .2        ULC-S525-1978, Audible Signal Appliances for Fire Alarm Systems.
- .3        CAN/ULC-S526-M87, Visual Signal Appliances, Fire Alarm.
- .4        CAN/ULC-S527-M87 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      OBC-2012, Ontario Building Code.

**1.2                DESCRIPTION OF SYSTEM**

- .1        System includes:
  - .1        Existing control panel to carry out fire alarm and protection functions including receiving alarm signals, initiating general alarm, supervising system continuously, actuating zone annunciators, and initiating trouble signals.

**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 the Electrical General Requirements Section.

**1.5                OPERATION AND MAINTENANCE DATA**

- .1        Provide operation and maintenance data for Fire Alarm System components for incorporation into manual specified in the Electrical General Requirements Section.
- .2        Include:
  - .1        Operation and maintenance instructions for fire alarm system components 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.

## Part 2 Products

### 2.1 MATERIALS

- .1 Equipment and devices: ULC listed and labeled and supplied by single manufacturer.
- .2 Power supply: to CAN/ULC-S524.
- .3 Audible signal devices: to ULC-S525.
- .4 Visual signal devices: to CAN/ULC-S526.
- .5 Control unit: to CAN/ULC-S527.
- .6 Manual pull stations: to CAN/ULC-S528.
- .7 Thermal detectors: to CAN/ULC-S530.
- .8 Smoke detectors: to CAN/ULC-S529.
- .9 Smoke alarms: to CAN/ULC-S531.

### 2.2 SYSTEM OPERATION

- .1 Single stage operation. Operation of any alarm initiating device to:
  - .1 Cause audible signal devices to sound throughout building.
  - .2 Transmit signal to fire department via monitoring station.
  - .3 Cause zone of alarm device to be indicated on control panel and remote annunciator[s].
  - .4 Cause air conditioning and ventilating fans to shut down or to function so as to provide required control of smoke movement.
  - .5 Cause fire doors and smoke control doors if normally held open, to close automatically.

### 2.3 CONTROL PANEL

- .1 Existing control panel as manufactured by Edwards, Quickstart Series.
- .2 Single stage operation.
- .3 Zoned in conformance with annunciator schedule.
- .4 Non-coded.
- .5 Enclosure: EEMAC 1 , complete with lockable concealed hinged door, full viewing window, flush lock and 2 keys.

### 2.4 MANUAL ALARM STATIONS

- .1 Pull lever style, wall mounted semi-flush type, non-coded single pole normally open contact for single stage, English signage.
- .2 Where noted on drawings, stations are to be equipped with tamperproof guard equal to Stopper II Cat. # STI-1100.

## 2.5 AUTOMATIC ALARM INITIATING DEVICES

- .1 Thermal fire detectors: fixed temperature, non-restorable, rated 57°C (135° F) or 88°C (194° F) as indicated.
- .2 Thermal fire detectors, combination fixed temperature and rate of rise, non-restorable fixed temperature element, self-restoring rate of rise, fixed temperature 57°C (135° F) or 88°C (194° F), rate of rise 8.3°C (15° F) per minute.
- .3 Smoke detector: ceiling mounted, photo electric type, visual alarm indicator, complete with relay base where noted.
- .4 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.

## 2.6 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 24Vdc operation, selectable HIGH/LOW setting 94.5 dBa (high)/89.8 dBa (low) at 3 m (10') selectable 15/30/75/110 candela outlet (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.

### NOTE:

- .1 **Signal devices with integral strobe lights in high abuse areas (i.e. gymnasium, change rooms, etc.) must be provide with protective wireguards.**
- .2 **Any surface mounted signal devices must be provided with suitable backboxes supplied by the manufacturer.**
- .3 **Set signal devices in classrooms to LOW setting.**
- .4 **Provide synchronization modules to suit signal devices (if required by manufacturer).**

## 2.7 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.

**2.8 SPRINKLER AND SUPERVISED VALVE CONNECTIONS**

- .1 Sprinkler and standpipe system contacts shall be provided by the mechanical trade but connected into the fire alarm system by this contractor.

**2.9 END-OF-LINE DEVICES**

- .1 End-of-line devices to control supervisory current in alarm circuits and signalling circuits, sized to ensure correct supervisory current for each circuit. Open, short or ground fault in any circuit will alter supervisory current in that circuit, producing audible and visible alarm at main control panel and remotely at annunciators.
- .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.

**2.10 GRAPHIC DISPLAY (PASSIVE)**

- .1 Black and white layout of facility showing all zones as specified/indicated.
- .2 Display is to be found behind glass [approximate size: 500 mm x 500 mm (20" x 20")].
- .3 Finish frame to architects direction.

**2.11 APPROVED EQUIPMENT**

	<u>DEVICE</u>	<u>EDWARDS</u>
1	Control Panel: (existing)	
		Quickstart Series
2	Manual Alarm Stations	270 Series
3	Thermal Detectors	280-PL Series
4	Smoke Alarms	KIDDE Cat. # P4010ACLEDS CA
5	Smoke Detectors (System Type)	C2M-PDC

6	Smoke Detectors (System Type c/w Relay Base)	C2M-PDHRC
7	Horn	757 Series
8	Mini Horn	Genesis G1R-HD
9	Door Holder	1500 Series
10	Mini Horn complete with Strobe	Genesis G1R-HDVM
11	Strobe	G1R-VM
12	Remote Trouble Indicator	RTU

### Part 3 Execution

#### 3.1 INSTALLATION

- .1 Install systems in accordance with CAN/ULC-S524 (latest edition).
- .2 Install main control panel and connect to ac power supply.
- .3 Locate and install manual alarm stations and connect to alarm circuit wiring.
- .4 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.
- .5 Connect alarm circuits to main control panel.
- .6 Locate and install signal devices and connect to signaling circuits.  
Note: Any required surface mounted signalling devices must be provided with proper surface mounted boxes from fire alarm manufacturer.
- .7 Connect signaling circuits to main control panel.
- .8 Install end-of-line devices at end of alarm and signaling circuits no higher than 2.4 m (8' 0") above finish floor.
- .9 Install remote annunciator panels and connect to annunciator circuit wiring.
- .10 Locate and install door releasing devices.  
**Note: Door holders must release by way of local smoke detector and signal from main**

- .11 **The manufacturer and electrical contractor are to allow in their tender the cost to add five (5) additional signaling devices to be installed and verified in locations as directed by the consultant.**  
**NOTE: This installation and verification will be occurring after the audibility testing is complete.**
- .12 Sprinkler system: wire alarm and supervisory switches and connect to control panel.
- .13 Connect fire suppression systems to control panel.
- .14 Elevator controllers are to be connected with 4 #14 conductors in conduit from fire alarm control panel to signal elevator recall in the event of a general alarm.

### 3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Electrical General Requirements Section and CAN/ULC-S537 (latest edition).  
**NOTE: Entire fire alarm system and components are to be tested as per the noted code.**
- .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 signaling circuits to ensure proper operation of system.
  - .4 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.
    - .2 Test each conductor on all circuits for capability of providing alarm signal during ground-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 Qualifications:
  - .1 Persons performing any work on this fire alarm system must be CFAA certified. Submit certification upon request.
  - .2 **Provide “Integrated Testing” of this life safety system in conformance with the noted specification section. Include all associated costs in tender.**
- .4 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.

**END OF SECTION**

**PAGE INTENTIONALLY LEFT BLANK**