

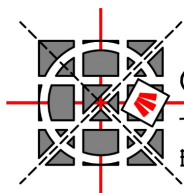
# **BID DOCUMENTS & SPECIFICATIONS**

**Issued for Tender & Permit**

## **TISS – MECHANICAL REPLACEMENT**

**for the  
Upper Canada District School Board**

**Date: 2026-04-08**  
**Project N° 24078**



**COLBOURNE & KEMBEL , ARCHITECTS INC.**

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Appendix A

Final Hazardous Building Materials Assessment (Management), Thousand Islands Secondary School, prepared by Pinchin Ltd, September 15, 2023, Pinchin File: 302783.034

Appendix B

Roof Plans: Existing Roofing Systems, Contractor and Warranty Information



**PROJECT**

THOUSAND ISLANDS SECONDARY SCHOOL – MECHANICAL REPLACEMENT

**OWNER**

UPPER CANADA DISTRICT SCHOOL BOARD  
225 Central Avenue West  
Brockville, ON K6V 5X1

**ARCHITECT**

COLBOURNE & KEMBEL, ARCHITECTS INC.  
739D Arlington Park Place  
Kingston, ON K7M 8M8

**STRUCTURAL ENGINEER**

EASTERN ENGINEERING GROUP INC.  
Brockville, ON

**MECHANICAL & ELECTRICAL ENGINEER**

McKEE ENGINEERING  
Ottawa, ON

**ROOFING CONSULTANT**

FISHBURN SHERIDAN  
Kingston, ON





## **Part 1 General**

### **1.1 WORK COVERED BY CONTRACT DOCUMENTS**

- .1 Work under this Contract covers the furnishing of all labour, materials, and equipment required for the Work described in the drawings and specifications prepared by Colbourne & Kembel, Architects Inc.

### **1.2 CODES**

- .1 Perform Work in accordance with the latest editions of the Ontario Building Code (OBC) and any other code of provincial or local application provided that in any case of conflict or discrepancy, the more stringent requirements shall apply.
- .2 Meet or exceed requirements of:
  - .1 Contract documents,
  - .2 Specified standards, codes and referenced documents.

### **1.3 SPECIFICATION GRAMMAR**

- .1 Specifications are written in the imperative mood, in an abbreviated form.
- .2 The imperative language of all technical sections is directed to the Contractor:
  - .1 This form of statement requires the Contractor or one of their engaged Subcontractors to perform such action or work.
  - .2 Perform all requirements whether stated imperatively or otherwise.

### **1.4 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING**

- .1 Execute work with least possible interference or disturbance to building operations occupants, and normal use of premises. Arrange with Owner to facilitate execution of work.
- .2 Use only entrances and corridor existing in building for moving workers and material.
  - .1 Protect walls and floors to approval of owner prior to use.
  - .2 Accept liability for damage, safety of equipment and overloading of existing equipment.

### **1.5 EXISTING SERVICES**

- .1 Notify, Consultant, Owner and utility companies of intended interruption of services and obtain required permission.
- .2 Where Work involves breaking into or connecting to existing services, carry out work at times as directed by governing authorities with minimum disturbance to tenant operations.
- .3 Establish location and extent of service lines in area of work before starting Work. Notify Consultant of findings.
- .4 Provide temporary services when directed by Consultant to maintain critical building and tenant services.
- .5 Provide adequate bridging over trenches which cross sidewalks or roads to permit normal traffic.
- .6 Where unknown services are encountered, immediately advise Consultant and confirm findings in writing.
- .7 Protect, relocate or maintain existing active services. When inactive services are encountered, cap off in manner approved by authorities having jurisdiction.
- .8 Record locations of maintained, re-routed and abandoned service lines.
- .9 Construct barriers, as required, in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

## **1.6 CONTRACT METHOD**

- .1 Construct Work under single, stipulated price contract. The Canadian Standard Construction Document CCDC 2, 2020, and the supplementary conditions are part of the Contract Documents.
- .2 The specification of all trades shall be carefully read by the Contractor so that he may make himself acquainted with the extent and nature of the work of other trades.

## **1.7 WORK SEQUENCE**

- .1 Construct Work in stages to accommodate Owner's continued use of premises during construction.
- .2 Co-ordinate Progress Schedule and co-ordinate with Owner Occupancy during construction.
- .3 Maintain fire access/control.
- .4 Protect workers and public safety.

## **1.8 SCHEDULE AND CONTRACTOR USE OF PREMISES**

- .1 For the periods of July 2, 2026 to August 28, 2026, and July 2, 2027 to August 27, 2027 the Contractor will have exclusive use of the areas to be renovated.
- .2 Work may be done throughout the school year outside of regular school hours and as coordinated with the Owner.
- .3 Substantial completion by August 31, 2027.
- .4 The Contractor will be provided with a key and alarm code to the building so that they may have access at any time.
- .5 Co-ordinate use of premises under direction of Owner.
- .6 Obtain and pay for use of additional storage or work areas needed for operations under this Contract.

## **1.9 DOCUMENTS REQUIRED**

- .1 Maintain at job site, one copy of each document as follows:
  - .1 Contract Drawings.
  - .2 Specifications.
  - .3 Addenda.
  - .4 Reviewed Shop Drawings.
  - .5 List of Outstanding Shop Drawings.
  - .6 Change Orders.
  - .7 Other Modifications to Contract.
  - .8 Field Test Reports.
  - .9 Copy of Approved Work Schedule.
  - .10 Health and Safety Plan and Other Safety Related Documents.
  - .11 Other documents as specified.

## **1.10 PROJECT MEETINGS**

- .1 Hold construction project meeting bi-weekly at site office.
- .2 Contractor will assume responsibility for recording and distributing minutes to all interested parties within 7 days of meeting.

## **Part 2 Products**

### **2.1 NOT USED**

- .1 Not used.

**Part 3 Execution**

**3.1 NOT USED**

.1 Not used.

**END OF SECTION**



## **Part 1 General**

### **1.1 REFERENCE STANDARDS**

- .1 Canadian Construction Documents Committee (CCDC)
  - .1 CCDC 2-2020, Stipulated Price Contract.
- .2 Project Supplementary Conditions

### **1.2 CASH ALLOWANCES**

- .1 Refer to CCDC 2, GC 4.1.
- .2 Include in Contract Price specified cash allowances.
- .3 Cash allowances, unless otherwise specified, cover net cost to Contractor of services, products, construction machinery and equipment, freight, handling, unloading, storage installation and other authorized expenses incurred in performing Work.
- .4 Contract Price, and not cash allowance, includes Contractor's overhead and profit in connection with such cash allowance.
- .5 Contract Price will be adjusted by written order to provide for excess or deficit to each cash allowance.
- .6 Where costs under a cash allowance exceed amount of allowance, Contractor will be compensated for excess incurred and substantiated plus allowance for overhead and profit as set out in Contract Documents.
- .7 Include progress payments on accounts of work authorized under cash allowances in Consultant's monthly certificate for payment.
- .8 Prepare schedule jointly with Consultant and Contractor to show when items called for under cash allowances must be authorized by Consultant for ordering purposes so that progress of Work will not be delayed.
- .9 Include a total of \$100,000.00 in the Contract for the following cash allowances:
  - .1 Include an allowance of \$100,000.00 for work associated with the ground grid study.

## **Part 2 Products**

### **2.1 NOT USED**

- .1 Not Used.

## **Part 3 Execution**

### **3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**



## **Part 1 General**

### **1.1 SCHEDULES REQUIRED**

- .1 Contractor shall submit their Construction Schedule for review within seven days after award of contract utilizing the critical path method. This schedule shall be updated monthly with both hard copy and electronic copy forwarded to the Consultant. Monthly updates must include actual percentages complete. The Construction Schedule will be shown as a line item on the Contractor's Cost Breakdown. Failure to provide monthly updates may result in the contractor's request for payment being returned.
- .2 The CPM Schedule shall include complete sequence of construction activities.
- .3 Include dates for commencement and completion of each major element of construction.
- .4 Show projected percentage of completion of each item as of first day of month.
- .5 Indicate progress of each activity to date of submission schedule.
- .6 Show changes occurring since previous submission of schedule:
  - .1 Major changes in scope.
  - .2 Activities modified since previous submission.
  - .3 Revised project icons of progress and completion.
  - .4 Other identifiable changes.
- .7 Provide a narrative report to define:
  - .1 Problem areas, anticipated delays, and impact on schedule.
  - .2 Corrective action recommended and its effect.

## **Part 2 Products**

### **2.1 NOT USED.**

- .1 Not Used.

## **Part 3 Execution**

### **3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**





## **Part 1 General**

### **1.1 ADMINISTRATIVE REQUIREMENTS**

- .1 Work affected by submittal shall not proceed until review is complete.
- .2 Present shop drawings, product data, samples and mock-ups in SI Metric units.
- .3 Where items or information is not produced in SI Metric units converted values are acceptable.
- .4 Review submittals before submission to Consultant . This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and coordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned without being examined and considered rejected.
- .5 Notify Consultant, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.
- .6 Verify site measurements and affected adjacent Work are coordinated.
- .7 Contractor's responsibility for errors and omissions in submission is not relieved by Consultant's review of submittals.
- .8 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Consultant review.
- .9 Keep one reviewed copy of each submission on site.

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

- .1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
- .2 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been coordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to Contract drawings and specifications.
- .3 Allow 10 working days for Consultant's review of each submission.
- .4 Adjustments made on shop drawings by Consultant are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Consultant prior to proceeding with Work.
- .5 Make changes in shop drawings as Consultant may require, consistent with Contract Documents. When resubmitting, notify Consultant in writing of revisions other than those requested.
- .6 Accompany submissions with transmittal letter, containing:
  - .1 Date.
  - .2 Project title and number.
  - .3 Contractor's name and address.
  - .4 Identification and quantity of each shop drawing, product data, and sample.
  - .5 Other pertinent data.
- .7 Submissions to include:
  - .1 Date and revision dates.
  - .2 Project title and number.
  - .3 Name and address of:
    - .1 Subcontractor.
    - .2 Supplier.
    - .3 Manufacturer.

- .4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of site measurements and compliance with Contract Documents.
- .5 Details of appropriate portions of Work as applicable:
  - .1 Fabrication.
  - .2 Layout, showing dimensions, including identified site dimensions and clearances.
  - .3 Setting or erection details.
  - .4 Capacities.
  - .5 Performance characteristics.
  - .6 Standards.
  - .7 Operating weight.
  - .8 Wiring diagrams.
  - .9 Single line and schematic diagrams.
  - .10 Relationship to adjacent work.
- .8 After Consultant's review, distribute copies.
- .9 Submit Electronic copies of shop drawings for each requirement requested in specification Sections.
- .10 Delete information not applicable to project.
- .11 Supplement standard information to provide details applicable to project.
- .12 If upon review by Consultant, no errors or omissions are discovered or if only minor corrections are made, Copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.

## **Part 2 Products**

### **2.1 NOT USED**

- .1 Not Used.

## **Part 3 Execution**

### **3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

## **Part 1 General**

### **1.1 REFERENCES**

- .1 Submit to Consultant and Owner copies of the following documents, including updates issued:
  - .1 Health and Safety Program submit, prior to commencement of work on the work site.
  - .2 Reports or directions issued by authorities having jurisdiction, immediately upon issuance from that authority.
  - .3 Accident or Incident Reports, within 24 hrs of occurrence.
- .2 Submit other data, information and documentation upon request by the Consultant as stipulated elsewhere in this section.

### **1.2 COMPLIANCE REQUIREMENTS**

- .1 Comply with the latest edition of the Ontario Occupational Health and Safety Act, and the Regulations made pursuant to the Act.
- .2 Observe and enforce construction safety measures required by:
  - .1 Ontario Building Code (latest edition).
  - .2 Provincial Worker's Compensation Board.
  - .3 Municipal statutes and ordinances.
- .3 In event of conflict between any provisions of above authorities the most stringent provision shall apply.
- .4 Provide and maintain Worker's Compensation Board coverage for all employees for the duration of the contract. Prior to commencement of the work, at each Interim Progress Claim, and prior to final payment, provide to the Consultant a letter of Clearance from the Worker's Compensation Board indicating that the Contractor's account is in good standing.
  - .1 Should the Contractor be a sole proprietor, provide documented proof in a form acceptable to the Consultant, of an alternative means of personal coverage that meets or exceeds the requirements set out above for Worker's Compensation Board coverage.

### **1.3 RESPONSIBILITY**

- .1 The Contractor is responsible for safety of persons and property on the work site and the general public circulating adjacent to work site operations to extent that they may be affected by conduct of work.
- .2 The Contractor is to enforce compliance by workers and other persons granted access to work site with safety requirements of Contract Documents, applicable federal, provincial, and local statutes, regulations, and ordinances, and with the Contractor's Health and Safety Program.
- .3 Should an unforeseen or peculiar safety related hazard or condition become evident during performance of work, immediately take measures to rectify the situation and prevent damage or harm. Advise the Consultant verbally and in writing of the hazard or condition.

### **1.4 SITE CONTROL AND ACCESS**

- .1 Control all work site access points and work site activities. Delineate and isolate the work site from adjacent and surrounding areas by use of appropriate means to maintain control of all work site access points.
- .2 Make provisions for granting permission to access onto work site to all persons who require access. Procedures for granting permission to access are to be in accordance

with the Ontario Occupational Health and Safety Act, and the Regulations made pursuant to the Act and the Contractor's Health and Safety Program.

- .3 Ensure persons granted access to the work site are in possession of and wear the minimum personal protective equipment (PPE) designated by the Contractor's Health and Safety Program. Ensure persons granted access to the work site are provided with, trained in the use of, and wear, appropriate PPE that are required above and beyond the designated minimums previously noted and as specifically related to the work site activity that they are involved in. Be responsible for the efficacy of the PPE that is provided above and beyond the designated minimums.
- .4 Erect signage at access points and at other strategic locations around the work site clearly identifying the work site area(s) as being "off-limits" to non-authorized persons. Signage must be professionally made with well understood graphic symbols and is not to be used as advertising but for the specific use as related to site safety and key contact information.
  - .1 Information to be provided on the signage is as follows:
    - .1 Project Name/Description:
    - .2 Contractor Company Name:
    - .3 Project Superintendent's Name/Phone No.:
- .5 Secure the work site at all times to protect against un-authorized access.

## 1.5 FILING OF NOTICE

- .1 File Notice of Project and any other required Notices with the Provincial/Territorial Authorities prior to commencement of the work. Provide the Owner with a copy of the filed Notice(s) prior to commencement of the work.

## 1.6 PERMITS

- .1 Obtain permits, licenses and compliance certificates, such as ESA, Plumbing permit etc., at appropriate times and frequencies as required by the authorities having jurisdiction.
- .2 Post all permits, licenses and compliance certificates on work site.
- .3 Owner to provide building permit.

## 1.7 ACCIDENT REPORTING

- .1 Investigate and report incidents and accidents as required Ontario Occupational Safety and Health Act, and the Regulations made pursuant to the Act.
- .2 For the purpose of this contract immediately investigate and provide a report on incidents and accidents that involve:
  - .1 A resulting injury that may or may not require medical aid but involves lost time at work by the injured person(s).
  - .2 Exposure to toxic chemicals or substances.
  - .3 Property damage.
  - .4 Interruption to adjacent and/or integral infrastructure operations with potential loss implications.
- .3 In the investigation and reporting of incidents and accidents, the Contractor is required to respond in a timely fashion to correct the action that was deemed to have caused the incident and/or accident and advise in writing on the action taken to prevent a re-occurrence of the incident and/or accident.

## 1.8 RECORDS ON SITE

- .1 Maintain on site a copy of the safety documentation as specified in this section and any other safety related reports and documents issued to or received from the authorities having jurisdiction.

**Part 2 Products**

**2.1 NOT USED**

.1 Not used.

**Part 3 Execution**

**3.1 NOT USED**

.1 Not used.

**END OF SECTION**



## **Part 1 General**

### **1.1 REPORTING FIRES**

- .1 Know location of nearest fire alarm box and telephone, including emergency phone number.
- .2 Report immediately all fire incidents to Fire Department as follows:
  - .1 activate nearest fire alarm box; or
  - .2 telephone 911 from local phone; or
  - .3 from cellular phone dial 911 and tell 911 operator the location of the fire
- .3 Person calling in alarm will remain on site to direct Fire Department to scene of fire.
- .4 When reporting fire by telephone, give location of fire, name or number of building and be prepared to verify the location.

### **1.2 INTERIOR AND EXTERIOR FIRE PROTECTION AND ALARM SYSTEMS**

- .1 Fire protection and alarm system will not be:
  - .1 obstructed;
  - .2 shut off; and/or
  - .3 left inactive at end of working day without pre-arrangement with Owner.
- .2 Fire hydrants, standpipes and hose systems will not be used for other than fire-fighting purposes unless authorized by Fire Chief.

### **1.3 FIRE EXTINGUISHERS**

- .1 Supply fire extinguishers, as necessary, to protect work in progress and contractor's physical plant on site.

### **1.4 ACCESS FOR FIRE FIGHTING**

- .1 Provide and maintain access for firefighting operations in accordance with NFC.
- .2 Submit written notification to Fire Chief a minimum of five Working Days before operation of activities that may cause problems that might impede fire department equipment access and personnel response including
  - .1 violation of minimum horizontal and overhead clearances
  - .2 other operations as directed by Fire Chief, or
  - .3 erecting of barricades and digging of trenches.
- .3 Maintain a minimum 6.0-m clear horizontal width for access routes, or as otherwise directed by Fire Chief.
- .4 Maintain a minimum 5.0-m vertical clearance for access routes, or as otherwise directed by Fire Chief.
- .5 Provide and maintain a safe exit path from all required building exits away from the building. Any exit paths within the designated area of work to be maintained by contractor.

### **1.5 SMOKING RESTRICTIONS**

- .1 No smoking on school property at any time as per the Smoke Free Ontario Act.

### **1.6 QUESTIONS OR CLARIFICATION**

- .1 Direct questions and requests for clarification on Fire Safety in addition to above requirements to Fire Chief.

### **1.7 FIRE INSPECTION**

- .1 Coordinate site inspections by Fire Chief through Project Manager.
- .2 Allow Fire Chief unrestricted access to work site.
- .3 Cooperate with Fire Chief during routine fire safety inspection of Work site.
- .4 Immediately remedy unsafe fire situations observed by Fire Chief.

## **1.8 HOT WORK**

- .1 A Hot Work Permit is required for any operations involving open flames or work and equipment producing heat or sparks. This work includes but is not necessarily limited brazing, cutting, grinding, soldering, torching and cadwelding.
- .2 Fire watches are required during all hot work. It is the Contractor's responsibility to provide all labour material and equipment to include personnel for the fire watch. Fire watch to continue for a minimum of 30 minutes after completion of work, including end of work day, coffee breaks and lunch breaks.
- .3 Fully comply with all required precautions indicated on the hot work permit checklist. Provide owner with an electronic copy of each permit for Hot Work. Leave Hard Copy of the Original on Site with the Custodian.

## **Part 2 Products**

### **2.1 NOT USED**

- .1 NOT USED

## **Part 3 Execution - Not Used**

**END OF SECTION**



## **Part 1 General**

### **1.1 FIRES**

- .1 Fires and burning of rubbish on site is not permitted.

### **1.2 DISPOSAL OF WASTES**

- .1 Do not bury rubbish and waste materials on site.
- .2 Do not dispose of waste or volatile materials, such as mineral spirits, oil or paint thinner into waterways, storm or sanitary sewers.

## **Part 2 Products**

### **2.1 NOT USED**

- .1 Not Used.

## **Part 3 Execution - Not Used**

**END OF SECTION**



## **Part 1 General**

### **1.1 SECTION INCLUDES**

- .1 Inspection and testing, administrative and enforcement requirements.
- .2 Equipment and system adjust and balance.

### **1.2 INSPECTION**

- .1 Allow Consultant access to Work. If part of Work is in preparation at locations other than Place of Work, allow access to such Work whenever it is in progress.
- .2 Give timely notice requesting inspection if Work is designated for special tests, inspections or approvals by Consultant instructions, or law of Place of Work.
- .3 If Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work.
- .4 Consultant may order any part of Work to be examined if Work is suspected to be not in accordance with Contract Documents. If, upon examination such work is found not in accordance with Contract Documents, correct such Work and pay cost of examination and correction. If such Work is found in accordance with Contract Documents, Owner shall pay cost of examination and replacement.

### **1.3 INDEPENDENT INSPECTION AGENCIES**

- .1 Independent Inspection/Testing Agencies may be engaged by Owner for purpose of inspecting and/or testing portions of Work. Cost of such services will be borne by Owner.
- .2 Provide equipment required for executing inspection and testing by appointed agencies.
- .3 Employment of inspection/testing agencies does not relax responsibility to perform Work in accordance with Contract Documents.
- .4 If defects are revealed during inspection and/or testing, appointed agency will request additional inspection and/or testing to ascertain full degree of defect. Correct defect and irregularities as advised by Consultant at no cost. Pay costs for retesting and re inspection.

### **1.4 ACCESS TO WORK**

- .1 Allow inspection/testing agencies access to Work, off site manufacturing and fabrication plants.
- .2 Co-operate to provide reasonable facilities for such access.

### **1.5 PROCEDURES**

- .1 Notify appropriate agency and Consultant in advance of requirement for tests, in order that attendance arrangements can be made.
- .2 Submit samples and/or materials required for testing, as specifically requested in specifications. Submit with reasonable promptness and in an orderly sequence so as not to cause delay in Work.
- .3 Provide labour and facilities to obtain and handle samples and materials on site. Provide sufficient space to store and cure test samples.

### **1.6 REJECTED WORK**

- .1 Remove defective Work, whether result of poor workmanship, use of defective products or damage and whether incorporated in Work or not, which has been rejected by Consultant as failing to conform to Contract Documents.  
Replace or re-execute in accordance with Contract Documents.

- .2 Make good other Contractor's work damaged by such removals or replacements promptly.
- .3 If in opinion of Consultant it is not expedient to correct defective Work or Work not performed in accordance with Contract Documents, Owner may deduct from Contract Price difference in value between Work performed and that called for by Contract Documents, amount of which shall be determined by Consultant.

#### **1.7 REPORTS**

- .1 Submit electronic copy of inspection and test reports.
- .2 Provide copies to Subcontractor of work being inspected or tested or manufacturer or fabricator of material being inspected or tested.

#### **1.8 EQUIPMENT AND SYSTEMS**

- .1 Submit adjustment and balancing reports for mechanical, electrical and building equipment systems.
- .2 Refer to Section 01 78 00 for definitive requirements.

### **Part 2 Products**

#### **2.1 NOT USED**

- .1 Not Used.

### **Part 3 Execution**

#### **3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1 General**

**1.1 SECTION INCLUDES**

- .1 Temporary utilities.

**1.2 INSTALLATION AND REMOVAL**

- .1 Provide temporary utilities controls in order to execute work expeditiously.
- .2 Remove from site all such work after use.

**1.3 WATER SUPPLY**

- .1 Owner will provide continuous supply of potable water for construction use.
- .2 Arrange for connection with appropriate utility company and pay costs for installation, maintenance and removal.

**1.4 TEMPORARY HEATING AND VENTILATION**

- .1 Contractor to provide temporary heat and electrical if required.
- .2 Be responsible for damage to Work due to failure in providing adequate heat and protection during construction.

**1.5 TEMPORARY POWER AND LIGHT**

- .1 Owner will pay for temporary power during construction for temporary lighting and operating of power tools.
- .2 Arrange for connection with appropriate utility company. Pay costs for installation, maintenance and removal.
- .3 Provide and maintain temporary lighting throughout project. Ensure level of illumination on all floors and stairs is not less than 162 lx.

**1.6 TEMPORARY COMMUNICATION FACILITIES**

- .1 Provide and pay for temporary telephone, fax and data lines necessary for own use.

**1.7 FIRE PROTECTION**

- .1 Provide and maintain temporary fire protection equipment during performance of Work required by insurance companies having jurisdiction and governing codes, regulations and bylaws.
- .2 Burning rubbish and construction waste materials is not permitted on Site.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution - Not Used**

**END OF SECTION**



## **Part 1 General**

### **1.1 SECTION INCLUDES**

- .1 Construction aids.
- .2 Office and sheds.
- .3 Parking.
- .4 Project identification.

### **1.2 INSTALLATION AND REMOVAL**

- .1 Provide construction facilities in order to execute work expeditiously.
- .2 Remove from site all such work after use.

### **1.3 SCAFFOLDING**

- .1 Provide and maintain scaffolding, ramps and ladders.

### **1.4 HOISTING**

- .1 Provide, operate and maintain hoists and cranes required for moving of workers, materials and equipment. Make financial arrangements with Subcontractors for their use of hoists.
- .2 Hoists and cranes to be operated by qualified operator.

### **1.5 SITE STORAGE/LOADING**

- .1 Confine work and operations of employees by Contract Documents. Do not unreasonably encumber premises with products.
- .2 Do not load or permit to load any part of Work with weight or force that will endanger Work.

### **1.6 CONSTRUCTION PARKING**

- .1 Parking will be permitted on site.
- .2 Provide and maintain adequate access to project site.
- .3 Use existing roads for access to project site. Make good damage resulting from Contractor's use of roads and site.

### **1.7 OFFICES**

- .1 Provide Contractor's site office heated to 22 degrees C, lighted 750 lx and ventilated, of sufficient size to accommodate site meetings and furnished with drawing laydown table.
- .2 Provide marked and fully stocked first-aid case in a readily available location.
- .3 Subcontractors to provide their own offices as necessary. Direct location of these offices.
- .4 Locate on site as directed by the Owner.
- .5 Install on site within two (2) weeks of contract award. Remove from site at completion of construction contract.

### **1.8 EQUIPMENT, TOOL AND MATERIALS STORAGE**

- .1 Provide and maintain, in clean and orderly condition, lockable weatherproof sheds for storage of tools, equipment and materials.
- .2 Locate materials not required to be stored in weatherproof sheds on site in manner to cause least interference with work activities.

### **1.9 SANITARY FACILITIES**

- .1 Provide sanitary facilities for work force in accordance with governing regulations and ordinances.
- .2 Post notices and take precautions as required by local health authorities. Keep area and premises in sanitary condition.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution - Not Used**

**END OF SECTION**



## **Part 1 General**

### **1.1 SECTION INCLUDES**

- .1 Barriers.
- .2 Environmental Controls.
- .3 Fire Routes.

### **1.2 INSTALLATION AND REMOVAL**

- .1 Provide temporary controls in order to execute Work expeditiously.
- .2 Remove from site all such work after use.

### **1.3 HOARDING**

- .1 Erect temporary site enclosures to contain designated construction areas using new 1.8 m high temporary portable fencing. Panels to have 42mm welded galvanized frames with non-climbable mesh.

### **1.4 GUARD RAILS AND BARRICADES**

- .1 Provide secure, rigid guard rails and barricades around deep excavations, open shafts, open stair wells, open edges of floors.
- .2 Provide as required by governing authorities.

### **1.5 WEATHER ENCLOSURES**

- .1 Provide weather tight closures to unfinished door and window openings, tops of shafts and other openings in floors and roofs.
- .2 Close off floor areas where walls are not finished; seal off other openings; enclose building interior work for temporary heat.
- .3 Design enclosures to withstand wind pressure and snow loading.

### **1.6 DUST TIGHT SCREENS**

- .1 Provide dust tight screens or insulated partitions to localize dust generating activities, and for protection of workers, finished areas of Work and public.
- .2 Maintain and relocate protection until such work is complete.

### **1.7 FIRE ROUTES**

- .1 Maintain access to property including overhead clearances for use by emergency response vehicles.

### **1.8 PROTECTION FOR OFF-SITE AND PUBLIC PROPERTY**

- .1 Protect surrounding private and public property from damage during performance of Work.
- .2 Be responsible for damage incurred.

### **1.9 PROTECTION OF BUILDING FINISHES**

- .1 Provide necessary screens, covers, and hoardings.
- .2 Be responsible for damage incurred due to lack of or improper protection.

## **Part 2 Products**

**2.1 NOT USED**

.1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

.1 Not Used.

**END OF SECTION**

## **Part 1 General**

### **1.1 SECTION INCLUDES**

- .1 Product quality, availability, storage, handling, protection, and transportation.
- .2 Manufacturer's instructions.
- .3 Quality of Work, coordination and fastenings.
- .4 Existing facilities.

### **1.2 QUALITY**

- .1 Products, materials, equipment and articles incorporated in Work shall be new, not damaged or defective, and of best quality (as per specifications) for purpose intended. If requested, furnish evidence as to type, source and quality of products provided.
- .2 Defective products, whenever identified prior to completion of Work, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility, but is precaution against oversight or error. Remove and replace defective products at own expense and be responsible for delays and expenses caused by rejection.
- .3 Should disputes arise as to quality or fitness of products, decision rests strictly with Consultant based upon requirements of Contract Documents.
- .4 Unless otherwise indicated in specifications, maintain uniformity of manufacture for any particular or like item throughout building.
- .5 Permanent labels, trademarks and nameplates on products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.
- .6 In specification sections where a specific manufacturer and/or product is specified as "an acceptable product is:" other manufacturers products meeting this standard ,as determined by the Consultant, will be accepted as an alternative unless specified otherwise.

### **1.3 AVAILABILITY**

- .1 Immediately upon signing Contract, review product delivery requirements and anticipate foreseeable supply delays for items. If delays in supply of products are foreseeable, notify Consultant of such, in order that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of Work.
- .2 In event of failure to notify Consultant at commencement of Work and should it subsequently appear that Work may be delayed for such reason, Consultant reserves right to substitute more readily available products of similar character, at no increase in Contract Price or Contract Time.

### **1.4 STORAGE, HANDLING AND PROTECTION**

- .1 Handle and store products in manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.
- .2 Store packaged or bundled products in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in Work.
- .3 Store products subject to damage from weather in weatherproof enclosures.
- .4 Store cementitious products clear of earth or concrete floors, and away from walls.
- .5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.
- .6 Store sheet materials, lumber on flat, solid supports and keep clear of ground. Slope to shed moisture.

- .7 Store and mix paints in heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.
- .8 Remove and replace damaged products at own expense and to satisfaction of Consultant.

#### **1.5 TRANSPORTATION**

- .1 Pay costs of transportation of products required in performance of Work.

#### **1.6 MANUFACTURER'S INSTRUCTIONS**

- .1 Unless otherwise indicated in specifications, install or erect products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with products. Obtain written instructions directly from manufacturers.
- .2 Notify Consultant in writing, of conflicts between specifications and manufacturer's instructions, so that Consultant will establish course of action.
- .3 Improper installation or erection of products, due to failure in complying with these requirements, authorizes Consultant to require removal and re-installation at no increase in Contract Price or Contract Time.

#### **1.7 QUALITY OF WORK**

- .1 Ensure Quality of Work is of highest standard, executed by workers experienced and skilled in respective duties for which they are employed. Immediately notify Consultant if required Work is such as to make it impractical to produce required results.
- .2 Do not employ anyone unskilled in their required duties. Consultant reserves right to require dismissal from site, workers deemed incompetent or careless.
- .3 Decisions as to standard or fitness of Quality of Work in cases of dispute rest solely with Consultant, whose decision is final.

#### **1.8 CO-ORDINATION**

- .1 Ensure co-operation of workers in laying out Work. Maintain efficient and continuous supervision.
- .2 Be responsible for coordination and placement of openings, sleeves and accessories.

#### **1.9 CONCEALMENT**

- .1 In finished areas conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise.
- .2 Before installation inform Consultant if there is interference. Install as directed by Consultant.

#### **1.10 REMEDIAL WORK**

- .1 Perform remedial work required to repair or replace parts or portions of Work identified as defective or unacceptable. Co-ordinate adjacent affected Work as required.
- .2 Perform remedial work by specialists familiar with materials affected. Perform in a manner to neither damage nor put at risk any portion of Work.

#### **1.11 LOCATION OF FIXTURES**

- .1 Consider location of fixtures, outlets, and mechanical and electrical items indicated as approximate.
- .2 Inform Consultant of conflicting installation. Install as directed.

#### **1.12 FASTENINGS**

- .1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless indicated otherwise. All fasteners shall be compatible with materials being used (eg. pressure treated wood).
- .2 Prevent electrolytic action between dissimilar metals and materials.
- .3 Use non-corrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in affected specification Section.
- .4 Space anchors within individual load limit or shear capacity and ensure they provide positive permanent anchorage. Wood, or any other organic material plugs are not acceptable.
- .5 Keep exposed fastenings to a minimum, space evenly and install neatly.
- .6 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

#### **1.13 FASTENINGS - EQUIPMENT**

- .1 Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.
- .2 Use heavy hexagon heads, semi-finished unless otherwise specified. Use No. 304 stainless steel for exterior areas.
- .3 Bolts may not project more than one diameter beyond nuts.
- .4 Use plain type washers on equipment, sheet metal and soft gasket lock type washers where vibrations occur. Use resilient washers with stainless steel.

#### **1.14 PROTECTION OF WORK IN PROGRESS**

- .1 Prevent overloading of parts of building. Do not cut, drill or sleeve load bearing structural member, unless specifically indicated without written approval of Consultant.

#### **1.15 EXISTING UTILITIES**

- .1 When breaking into or connecting to existing services or utilities, execute Work at times directed by local governing authorities, with minimum of disturbance to Work, and pedestrian and vehicular traffic.
- .2 Protect, relocate or maintain existing active services. When services are encountered, cap off in manner approved by authority having jurisdiction. Stake and record location of capped service.

### **Part 2 Products**

#### **2.1 NOT USED**

- .1 Not Used.

### **Part 3 Execution**

#### **3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**



## **Part 1 General**

### **1.1 SECTION INCLUDES**

- .1 Requirements and limitations for cutting and patching the Work.

### **1.2 RELATED SECTIONS**

- .1 Individual product Sections: cutting and patching incidental to work of section. Advance notification to other sections required.

### **1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit written request before cutting or altering to existing conditions which may affect the following:
  - .1 Structural integrity of any element of Project.
  - .2 integrity of weather-exposed and moisture-resistant elements
  - .3 efficiency, maintenance, safety, or accessibility of operational elements
  - .4 visual qualities of sight-exposed elements.
  - .5 Work of Owner or separate Contractor
- .2 Include in request:
  - .1 identification of the Project.
  - .2 location and description of affected work.
  - .3 Statement on necessity for cutting or alteration.
  - .4 Description of proposed Work, and products to be used.
  - .5 Alternatives to cutting and patching.
  - .6 Effect on Work of Owner or separate contractor.
  - .7 Written permission of affected separate contractor.
  - .8 Date and time work will be executed.

### **1.4 MATERIALS**

- .1 Required for original installation.
- .2 Change in Materials: Submit request for substitution in accordance with Section 01 33 00.

### **1.5 PREPARATION**

- .1 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.
- .2 After uncovering, inspect conditions affecting performance of Work.
- .3 Beginning of cutting or patching means acceptance of existing conditions.
- .4 Provide supports to assure structural integrity of surroundings; provide devices and methods to protect other portions of project from damage.
- .5 Provide protection from elements for areas which may be exposed by uncovering work; maintain excavations free of water.

### **1.6 EXECUTION**

- .1 All necessary cutting and patching of work for the Mechanical and Electrical or associated trades shall be done by the General Contractor. General Contractor is to coordinate and schedule related subtrades prior to pouring concrete, installing finishes to ensure that sub-trades routing, installation of services, finishes, etc. are in place prior to installing.
- .2 Execute cutting, fitting, and patching required to make work fit properly together and as necessary for the installation of new and existing materials.

- .3 Where new work connects with existing and where existing work is altered, cut, patch and make good to match existing work.
- .4 Make good any damage resulting from work of this contract.
- .5 Tradesmen qualified in the work being cut and patched shall be employed to ensure that works are correctly done.
- .6 Core drill holes in areas after being located by the Trade concerned.
- .7 Whenever it becomes necessary to cut or interfere in any manner with existing services or apparatus, do so at such times as approved by the Consultant.
- .8 Whenever existing items are designated for relocation or removal, relocate or remove these items unless specified to be done by other sections of the Specification. All waste and debris shall be disposed of by the General Contractor.
- .9 Coordinate work of all sections, taking into account existing installations to ensure best arrangement of components in available space. For critical locations, consult with Consultant prior to commencing work.
- .10 Make good all surfaces and finishes to match existing in areas from which items have been removed or in which items are relocated. Cap off all existing services required to be severed to affect the alterations and do all other work necessary to make good such areas the Consultant's satisfaction.
- .11 Core drill holes in concrete floors for piping where not previously sleeved, Do not use mechanical hammers or drills without prior approval in writing.
- .12 Any cutting/patching required after completion of new works shall be done by the General Contractor at the Sub-Trade concerned's expense.
- .13 Maintain all fire separations. Provide fire stopping at all penetrations in accordance with CAN4-5115.
- .14 Uncover Work to install ill-timed Work.
- .15 Remove and replace defective and non-conforming Work.
- .16 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical Work.
- .17 Execute Work by methods to avoid damage to other Work, and which will provide proper surfaces to receive patching and finishing.
- .18 Cut rigid materials using masonry saw or core drill. Pneumatic or impact tools not allowed on masonry work without prior approval.
- .19 Restore work with new products in accordance with requirements of Contract Documents.
- .20 Fit Work to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- .21 At penetration of fire rated wall, ceiling, or floor construction, completely seal voids with firestopping material, full thickness of the construction element.
- .22 Refinish surfaces to match adjacent finishes. For continuous surfaces refinish to nearest intersection; for an assembly, refinish entire unit.
- .23 Conceal pipes, ducts and wiring in wall and ceiling construction of finished areas except where indicated otherwise.
- .24 Reinstate sidewalks and lawns to pre-construction conditions
- .25 Refer to the Hazardous Building Materials Assessment and the general specification notes relating to asbestos and hazardous materials abatement.
- .26 Masonry shall be saw cut and patching shall be toothed in to match existing adjacent finish.

**Part 2 Products - Not Used**

**Part 3 Execution - Not Used**

**END OF SECTION**



## **Part 1 General**

### **1.1 SECTION INCLUDES**

- .1 Progressive cleaning.
- .2 Final cleaning.

### **1.2 PROJECT CLEANLINESS**

- .1 Maintain Work in tidy condition, free from accumulation of waste products and debris, including that caused by Owner or other Contractors.
- .2 Remove waste materials from site at daily regularly scheduled times or dispose of as directed by Section 01 74 19. Do not burn waste materials on site.
- .3 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .4 Provide on-site containers for collection of waste materials and debris.
- .5 Provide and use clearly marked separate bins for recycling. Refer to Section 01 74 19 - Waste Management and Disposal.
- .6 Dispose of waste materials and debris from site and deposit in waste container at end of each working day.
- .7 Dispose of waste materials and debris at designated approved dumping areas off site.
- .8 Clean interior areas prior to start of finishing work, and maintain areas free of dust and other contaminants during finishing operations.
- .9 Store volatile waste in covered metal containers, and remove from premises at end of each working day.
- .10 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.
- .11 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- .12 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

### **1.3 FINAL CLEANING**

- .1 When Work is Substantially Performed remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.
- .2 Remove waste products and debris other than that caused by others, and leave Work clean and suitable for occupancy.
- .3 Prior to final review remove surplus products, tools, construction machinery and equipment.
- .4 Remove waste materials from site at regularly scheduled times. Do not burn waste materials on site.
- .5 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .6 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.
- .7 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fittings, walls, floors, and ceilings.
- .8 Clean lighting reflectors, lenses, and other lighting surfaces.
- .9 Vacuum clean and dust building interiors, behind grilles, louvres and screens.
- .10 Inspect finishes, fittings and equipment and ensure specified workmanship and operation.
- .11 Broom clean and wash exterior walks, steps and surfaces; rake clean other surfaces of grounds.

.12 Clean roofs, downspouts, and drainage systems.

**Part 2 Products**

**2.1 NOT USED**

.1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

.1 Not Used.

**END OF SECTION**

## **Part 1 General**

### **1.1 REGULATORY AGENCIES**

- .1 The Ontario Ministry of Environment (OME) in accordance with Section 7 of Ontario Regulation 103/94 requires a source separation program for the waste that will be generated in the construction or demolition of a structure.
- .2 The source separation program required shall:
  - .1 Deal separately with each of the categories of waste set out in Part III of the Schedule that have been source separated from other kinds of waste and also from each other category of waste in Part III; or
  - .2 Provide for removal from the building site of any commingled categories of waste set out in Part III of the Schedule and for the immediate separation of such waste from all other kinds of waste and also from each category of waste in Part III, at
    - .1 permanent premises of the person undertaking the construction project
    - .2 permanent premises of the person on whose behalf the construction project is undertaken or
    - .3 a waste disposal site operating under the authority of a certificate of approval
- .3 The source separation program shall be implemented before construction work begins on site.

### **1.2 SUBMITTAL**

- .1 Prepare and submit a waste reduction work plan. Describe management of construction wastes. Identify materials which can be recycled, reused and indicate methods proposed for reducing, reusing and recycling wastes.

### **1.3 WASTE COLLECTION AND DISPOSAL**

- .1 Separate and salvage materials suitable for reuse and/or recycling from general waste stream.
- .2 Provide on site facilities for collection, handling and storage of anticipated quantities of reusable and/or recyclable materials.
- .3 Locate containers in locations, to facilitate deposit of materials without hindering daily operations.
- .4 Collect, handle, store on site and transport off site, salvaged materials, salvaged for reuse and/or recycling in separate condition. Transport to authorized reuse/recycling location.
- .5 Separate non salvageable materials from salvaged items. Transport and deliver non salvageable items to licensed disposal facility.
- .6 Burying, burning, selling waste materials on site is prohibited.
- .7 Disposals of liquid wastes into waterways, sewers is prohibited.
- .8 Unless specified otherwise, materials for removal become Contractor's property.
- .9 Clean up work, storage and waste collection areas as work progresses.

## **Part 2 Products**

### **2.1 NOT USED**

- .1 Not Used.

## **Part 3 Execution - Not Used**

**END OF SECTION**

## **Part 1 General**

### **1.1 SECTION INCLUDES**

- .1 Administrative procedures preceding preliminary and final inspections of Work.

### **1.2 INSPECTION AND DECLARATION**

- .1 Contractor's Inspection: Contractor and all Subcontractors shall conduct an inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.
  - .1 Notify Consultant in writing of satisfactory completion of Contractor's Inspection and that corrections have been made.
  - .2 Request Consultant's Inspection.
- .2 Consultant's Inspection: Consultant and Contractor will perform inspection of Work to identify obvious defects or deficiencies. Contractor shall correct Work accordingly.
- .3 Completion: submit written certificate that following have been performed:
  - .1 Work has been completed and inspected for compliance with Contract Documents.
  - .2 Defects have been corrected and deficiencies have been completed.
  - .3 Work is complete and ready for Final Inspection.
- .4 Final Inspection: when items noted above are completed, request final inspection of Work by Consultant. If Work is deemed incomplete by Consultant, complete outstanding items and request re inspection.

## **Part 2 Products**

### **2.1 NOT USED**

- .1 Not Used.

## **Part 3 Execution**

### **3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**



## **Part 1 General**

### **1.1 SUBMISSION**

- .1 Prepare instructions and data using personnel experienced in maintenance and operation of described products.
- .2 Copy will be returned after final inspection, with Consultant's comments.
- .3 Revise content of documents as required prior to final submittal.
- .4 Submit to the Consultant one (1) hard copy and one USB thumb drive, PDF format of operating and maintenance manuals in English within 14 days of substantial completion.

### **1.2 FORMAT**

- .1 Organize data as instructional manual.
- .2 Binders: Vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.
- .3 When multiple binders are used correlate data into related consistent groupings.
  - .1 Identify contents of each binder on spine.
- .4 Cover: Identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.
- .5 Arrange content by systems, process flow under Section numbers and sequence of Table of Contents.
- .6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
- .7 Text: manufacturer's printed data, or typewritten data.
- .8 Drawings: Provide with reinforced punched binder tab.
  - .1 Bind in with text; fold larger drawings to size of text pages.

### **1.3 CONTENTS - PROJECT RECORD DOCUMENTS**

- .1 Table of Contents for Each Volume: provide title of project;
  - .1 Date of submission; names.
  - .2 Addresses, and telephone numbers of Contractor with name of responsible parties.
  - .3 Schedule of products and systems, indexed to content of volume.
- .2 For each product or system:
  - .1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.
- .3 Product Data: mark each sheet to identify specific products and component parts, and data applicable to installation; delete inapplicable information.
- .4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
- .5 Typewritten Text: As required to supplement product data.
  - .1 Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01 45 00 - Quality Control.

### **1.4 AS-BUILT DOCUMENTS AND SAMPLES**

- .1 In addition to requirements in General Conditions, maintain at the site for Consultant one record copy of:
  - .1 Contract Drawings.
  - .2 Specifications.
  - .3 Addenda.
  - .4 Change Orders and other modifications to Contract.
  - .5 Reviewed shop drawings, product data, and samples.

- .6 Field test records.
- .7 Inspection certificates.
- .8 Manufacturer's certificates.
- .2 Store record documents and samples in site office apart from documents used for construction.
  - .1 Provide files, racks, and secure storage.
- .3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual.
  - .1 Label each document "PROJECT RECORD" in neat, large, printed letters.
- .4 Maintain record documents in clean, dry and legible condition.
  - .1 Do not use record documents for construction purposes.
- .5 Keep record documents and samples available for inspection by Consultant.

## **1.5 RECORDING ACTUAL SITE CONDITIONS**

- .1 Contractor shall maintain two sets of white prints for record drawing purposes. Record changes and at completion of project submit one marked to the Consultant.
- .2 Use felt tip marking pens, maintaining separate colours for each major system, for recording information.
- .3 Record information concurrently with construction progress.
  - .1 Do not conceal Work until required information is recorded.
- .4 Contract Drawings and shop drawings: legibly mark each item to record actual construction, including:
  - .1 Measured depths of elements of foundation in relation to finish first floor datum.
  - .2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
  - .3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
  - .4 Site changes of dimension and detail.
  - .5 Changes made by change orders.
  - .6 Details not on original Contract Drawings.
  - .7 Referenced Standards to related shop drawings and modifications.
- .5 Specifications: legibly mark each item to record actual construction, including:
  - .1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.
  - .2 Changes made by Addenda and change orders.
- .6 Other Documents: Maintain manufacturer's certifications, inspection certifications, field test records, required by individual specifications Sections.
- .7 Provide digital photos, if requested, for site records.

## **1.6 FINAL SURVEY**

- .1 At completion of project, transfer recorded changes to Construction drawings and submit one set of as-built drawings to Consultant. As built drawing submission shall include one (1) marked copy of the construction drawings, one (1) hard copy of the As Built drawings and one (1) copy of As Built drawings in electronic .pdf format. All drawings shall be submitted and marked as built.

## **1.7 EQUIPMENT AND SYSTEMS**

- .1 For each item of equipment and each system include description of unit or system, and component parts.
  - .1 Give function, normal operation characteristics and limiting conditions.
  - .2 Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.



- .2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.
- .3 Include installed colour coded wiring diagrams.
- .4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences.
  - .1 Include regulation, control, stopping, shut-down, and emergency instructions.
  - .2 Include summer, winter, and any special operating instructions.
- .5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- .6 Provide servicing and lubrication schedule, and list of lubricants required.
- .7 Include manufacturer's printed operation and maintenance instructions.
- .8 Include sequence of operation by controls manufacturer.
- .9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- .10 Provide installed control diagrams by controls manufacturer.
- .11 Provide Contractor's coordination drawings, with installed colour coded piping diagrams.
- .12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- .13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- .14 Include test and balancing reports as specified.
- .15 Additional requirements: As specified in individual specification Sections.

## **1.8 MATERIALS AND FINISHES**

- .1 Building products, applied materials, and finishes: Include product data, with catalogue number, size, composition, and colour and texture designations.
- .2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .3 Moisture-protection and weather-exposed products: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .4 Additional requirements: As specified in individual specifications Sections.

## **1.9 DELIVERY, STORAGE, AND HANDLING**

- .1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.
- .2 Store in original and undamaged condition with manufacturer's seal and labels intact.
- .3 Store components subject to damage from weather in weatherproof enclosures.
- .4 Store paints and freezable materials in a heated and ventilated room.
- .5 Remove and replace damaged products at own expense and to satisfaction of Consultant.

## **1.10 WARRANTIES AND BONDS**

- .1 Assemble approved information in binder, submit upon acceptance of work and organize binder as follows:
  - .1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.
  - .2 List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.
  - .3 Obtain warranties and bonds, executed in duplicate by Subcontractors, suppliers, and manufacturers, within ten days after completion of applicable item of work.

- .4 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until the Date of Substantial Performance is determined.
- .5 Verify that documents are in proper form, contain full information, and are notarized.
- .6 Co-execute submittals when required.
- .7 Retain warranties and bonds until time specified for submittal.

## **Part 2 Products**

### **2.1 NOT USED**

- .1 Not Used.

## **Part 3 Execution**

### **3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

## **Part 1 General**

### **1.1 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Action Submittals: Provide the following submittals before starting any work of this Section:
  - .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Before proceeding with demolition of load bearing walls and where required by authority having jurisdiction submit for review by Consultant shoring drawings prepared by qualified professional engineer registered or licensed in the Province of Ontario, showing proposed method.
- .3 Prior to beginning of Work on site submit detailed Waste Reduction Workplan in accordance with Sections 01 74 19 - Waste Management and Disposal and indicate:
  - .1 Descriptions of and anticipated quantities in percentages of materials to be salvaged reused, recycled and landfilled.
  - .2 Schedule of selective demolition.
  - .3 Number and location of dumpsters.
  - .4 Anticipated frequency of tippage.
  - .5 Name and address of haulers waste facilities waste receiving organizations.

### **1.2 WASTE DISPOSAL AND MANAGEMENT**

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

### **1.3 SITE CONDITIONS**

- .1 Review "Designated Substance Report" and take precautions to protect environment.
- .2 If material resembling spray or trowel-applied asbestos or other designated substance listed as hazardous be encountered, stop work, take preventative measures, and notify Consultant immediately.
  - .1 Proceed only after receipt of written instructions have been received from Consultant.

## **Part 2 Products - Not Used**

## **Part 3 Execution**

### **3.1 PROTECTION**

- .1 Protection of In-Place Conditions:
  - .1 Prevent movement, settlement, or damage to adjacent parts of building to remain in place. Provide bracing and shoring required.
  - .2 Keep noise, dust, and inconvenience to occupants to minimum.
  - .3 Protect building systems, services and equipment.
  - .4 Provide temporary dust screens, covers, railings, supports and other protection as required.
- .2 Demolition/Removal:
  - .1 Remove parts of existing building to permit new construction.

### **3.2 DEMOLITION AND DISPOSAL**

- .1 Refer to demolition drawings and specifications for items to be salvaged for reuse.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

- .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED SECTIONS**

- .1 Section 07 21 16 – Blanket Insulation.
- .2 Section 07 21 29.03 – Sprayed Insulation – Polyurethane Foam.
- .3 Section 07 52 00 – Modified Bituminous Membrane Roofing.
- .4 Section 07 62 00 – Sheet Metal Flashing and Trim.
- .5 Section 07 92 00 – Joint Sealants.

**1.2 REFERENCES**

- .1 ASTM International
  - .1 ASTM A653/A653M-15, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .2 CSA Group (CSA)
  - .1 CSA A123.22-08 (R2013) - Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
  - .2 CSA B111-1974 (R2003), Wire Nails, Spikes and Staples.
  - .3 CSA O141-05 (R2014), Softwood Lumber.
  - .4 CSA O151-09 (R2014), Canadian Softwood Plywood.
  - .5 CAN/CSA-80 Series.
  - .6 CSA Series O80-15, Wood Preservation.
- .3 National Lumber Grades Authority (NLGA)
  - .1 Standard Grading Rules for Canadian Lumber 2010.
- .4 Underwriters' Laboratories of Canada (ULC)
  - .1 CAN/ULC-S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.
  - .2 CAN/ULC-S702-14, Standard for Mineral Fibre Thermal Insulation for Buildings.
  - .3 CAN/ULC-S702.2-10, Standard for Mineral Fibre Thermal Insulation for Buildings, Part 2: Application.
  - .4 CAN/ULC-S705.1-01, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density, Material Specification.
  - .5 CAN/ULC-S705.2-05, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density, Application.

### **1.3 QUALITY ASSURANCE**

- .1 Lumber identification: By grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.
- .2 Plywood identification: By grade mark in accordance with applicable CSA Standards.

### **1.4 MOCK-UPS**

- .1 Provide a 600 mm mock-up of wood blocking system, including closures for each detail or profile for review in a location designated by the Consultant in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Review mock-up to ensure design intent can be achieved. Verify all intersecting and adjoining elevations to ensure that continuity of roofing and closures can be achieved. Verify attachment, methods for securing and pullout strengths to ensure that work can support the anticipated loads and will remain in place against all wind, weather and service conditions without warping or deforming.

### **1.5 PRECAUTIONS**

- .1 Provide temporary protection, to the satisfaction of the Consultant, to render all wood blocking watertight, if for any reason permanent membrane protection cannot be provided within the same day. Ensure the base of any curbs are temporarily sealed to prevent water from entering below the curb assembly, or behind sheathing, should the roof assembly not be completed on the same day as the carpentry work.

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

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.
- .2 Delivery and acceptance requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and handling requirements:
  - .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store materials off ground with moisture barrier at both ground level and as a cover forming a well-ventilated enclosure, with drainage to prevent standing water.
  - .3 Replace defective or damaged materials with new.

**Part 2 Products**

**2.1 STRUCTURAL FRAMING**

- .1 Lumber: Unless specified otherwise, softwood, S4S, moisture content 19% or less in accordance with CSA O141 and NLGA Standard Grading Rules for Canadian Lumber.
- .2 Furring, blocking, nailing strips, grounds, rough bucks, curbs, fascia backing and sleepers, S2S is acceptable for all surfaces.
  - .1 Board sizes: "Standard" or better grade.
  - .2 Dimension sizes: "Standard" light framing or better grade.

**2.2 WOOD PRESERVATIVE**

- .1 Rough carpentry shall include lumber treated to CSA O80.
- .2 For treating on site, maximum allowable VOC limit 350 g/L.
- .3 Surface-applied wood preservative: Coloured or copper naphthenate or 5% pentachlorophenol solution, water repellent preservative.

**2.3 PANEL MATERIALS**

- .1 Canadian softwood plywood (CSP): To CSA O151, urea-formaldehyde free.
- .2 Fire-retardant-treated wood and plywood: to CAN/CSA-80 Series, impregnated with fire-retardant chemicals in solution under high pressure.

**2.4 FASTENERS**

- .1 Wood to wood fasteners: Wood screw #12 or as indicated, galvanized flat head, of sufficient length to completely penetrate through base minimum 25 mm.
- .2 Wood to steel deck fasteners: Screws to be factory coated with an additional corrosion protection.
  - .1 Standard of acceptance:
    - .1 Climaseal, or accepted alternate.
- .3 Plywood to concrete, brick or hollow masonry fasteners: 6 mm diameter screws. Length to provide minimum 32 mm and maximum 40 mm embedment into substrate as required. Type to be approved subject to results of pull tests.
  - .1 Standard of acceptance:
    - .1 Tapcon, or accepted alternate.
- .4 Expansion fasteners for wood plates and steel to concrete deck: AISI Type 304 stainless steel, with stainless nuts and washers.
  - .1 Standard of acceptance:
    - .1 Hilti Kwik Bolt TZ, or accepted alternate.

- .5 Adhesive anchors: Size noted on the drawings or size recommended by manufacturer. Co-ordinate selection of fastener with manufacturer of item to be secured and obtain structural engineers approval and written consent before proceeding.
  - .1 Standard of acceptance:
    - .1 HIT HY150 by HILTI, or accepted alternate.
- .6 Exposed fasteners for metal to wood or masonry: Use #10 cadmium plated hex screws with neoprene and steel washers. Minimum length 38 mm. Use lead shields, as required for anchoring. Colour of screw head to meet approval of Consultant.
  - .1 Standard of acceptance:
    - .1 Atlas Bolt, Rawl, or accepted alternate.
- .7 Nails, spikes and staples: To CSA B111.

## **2.5 ACCESSORIES**

- .1 Semi-rigid insulation to Section 07 21 16 – Blanket Insulation.
- .2 Metal closure: 0.56 mm (26 ga.) galvanized steel unless otherwise shown or specified.
- .3 Self-adhered membrane: To CSA A123.22, self-adhering membrane consisting of SBS rubberized asphalt compound laminated to a polyethylene film. Minimum thickness 1 mm.
  - .1 Standard of acceptance:
    - .1 Lastobond Shield HT by Soprema.
    - .2 PE200HT by Henry.
    - .3 AquaBarrier™ AVB by IKO.
    - .4 Or accepted alternate.
- .4 Spray-in-place foam insulation in accordance with Section 07 21 29.03 – Sprayed Insulation – Polyurethane Foam.

## **2.6 FINISHES**

- .1 Galvanizing: To ASTM A653/A653M, use galvanized fasteners for all work.

## **Part 3 Execution**

### **3.1 GENERAL INSTALLATION**

- .1 Extend air/vapour barrier seals up vertical surfaces and curbs and onto the deck as shown on the Drawings, to provide continuity.
- .2 Slope the top of all wood blocking at the roof perimeter in towards the roof at a minimum of 5%, unless otherwise shown on the Drawings.



- .3 Comply with requirements of NBC, supplemented by the following paragraphs.
- .4 Install furring and blocking as required to space-out and support casework, cabinets, wall and ceiling finishes, facings, fascia, soffit, siding and other work as required.
- .5 Align and plumb faces of furring and blocking to tolerance of 1:600.
- .6 Install rough bucks, nailers and linings to rough openings as required to provide backing for frames and other work.
- .7 Install wood, fascia backing, nailers, curbs and other wood supports as required and secure using galvanized steel fasteners.
- .8 Install wood backing, dressed, tapered and recessed slightly below top surface of roof insulation for roof hopper.
- .9 Install sleepers as indicated. Install level with weight distributed evenly on 25 mm Type 4 extruded polystyrene insulation or other support base as indicated.
- .10 Re-treat surfaces exposed by cutting, trimming or boring with liberal brush application of preservative before installation.

### **3.2 SECUREMENT OF WOOD BLOCKING**

- .1 Comply with more stringent requirements as required by drawings or Ontario Building Code requirements. Increase number and spacing of all fasteners by 50% for 2400 mm from all outside roof corners.
- .2 Install fasteners to the design intent to hold all wood blocking permanently in place to prevent warping, deflection and to resist all wind and weather conditions.
- .3 Secure wood to concrete in a staggered pattern with each row spaced at minimum 600 mm c/c with specified fasteners. Drill holes 13 mm deeper than depth of fastener penetration.
- .4 Secure wood to metal deck in a staggered pattern with each row spaced at 450 mm c/c with specified fasteners at minimum 450 mm c/c. Secure bottom nailer with minimum two rows of No. 10, galvanized steel screws at maximum spacing of 600 mm. Screws shall be of sufficient length to penetrate top flute of decking a minimum 13 mm and a maximum of 19 mm.
- .5 Install fasteners in two rows in the direction of the grain, offset one to another in a staggered fashion by approximately 50%. All fasteners shall be placed minimum 10 mm from any edge of framing.
- .6 Unless specified otherwise, the number of fasteners shall be doubled at all outside parapet corners, for a distance of 3 m from the corner.
- .7 For any exposed fastening, provide touch-up paint as required to coat all exposed surfaces of screws damaged during the driving process.

### **3.3 SHEATHING INSTALLATION**

- .1 Plywood:
  - .1 Not less than 2 mm gaps shall be provided between sheets, to allow for material expansion.
  - .2 Unless otherwise indicated, fasten plywood with a minimum of thirty-six fasteners per 1200 mm x 2400 mm sheet.

### **3.4 ERECTION**

- .1 Frame, anchor, fasten, tie and brace members to provide necessary strength and rigidity.
- .2 Countersink bolts where necessary to provide clearance for other work.
- .3 Bevel leading edge of wood panel products on vertical applications to facilitate membrane installation and as detailed on drawings.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 ASTM International
  - .1 ASTM C1320-10, Standard Practice for Installation of Mineral Fiber Batt and Blanket Thermal Insulation for Light Frame Construction.
- .2 CSA Group
  - .1 CSA B149 PACKAGE-10, Consists of B149.1, Natural Gas and Propane Installation Code and B149.2, Propane Storage and Handling Code.
- .3 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC-S604-2012, Standard for Factory-Built Type A Chimneys.
  - .2 CAN/ULC-S702-2012, Standard for Mineral Fibre Insulation for Buildings.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for blanket insulation and include product characteristics, performance criteria, physical size, finish and limitations.

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials off ground, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Replace defective or damaged materials with new.

**Part 2 Products**

**2.1 INSULATION**

- .1 Batt and blanket mineral fibre: Type 1 to CAN/ULC-S702, thickness as indicated.
  - .1 Acceptable product: COMFORTBATT as manufactured by Rockwool.

**Part 3 Execution**

**3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for blanket insulation application in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Consultant.
  - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied.

**3.2 INSULATION INSTALLATION**

- .1 Install insulation to maintain continuity of thermal protection to building elements and spaces and to ASTM C1320.
- .2 Fit insulation closely around electrical boxes, pipes, ducts, frames and other objects in or passing through insulation.
- .3 Do not compress insulation to fit into spaces.
- .4 Keep insulation minimum 75 mm from heat emitting devices such as recessed light fixtures, and minimum 50 mm from sidewalls of CAN/ULC-S604 Type A chimneys CSA B149.1 and CSA B149.2 Type B L vents.
- .5 Do not enclose insulation until it has been inspected and approved by Consultant.

**3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 Canadian Urethane Foam Contractors Association Inc. (CUFCA)
- .2 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC-S101-07, Standard Methods of Fire Tests of Building Construction and Materials.
  - .2 CAN/ULC-S102-10, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
  - .3 CAN/ULC-S705.1-01, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density, Material Specification. Includes Amendment 1.2.
  - .4 CAN/ULC-S705.2-05, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density, Application.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for polyurethane foam sprayed insulation and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Submit 2 copies of WHMIS 2015 SDS in accordance with Section 01 35 29.06 - Health and Safety Requirements and Section 01 35 43 - Environmental Procedures.

**1.3 QUALITY ASSURANCE**

- .1 Applicators to conform to CUFCA Quality Assurance Program.
- .2 Qualifications:
  - .1 Installer: person specializing in sprayed insulation installations with documented experience.
  - .2 Manufacturer: company with experience in producing of material used for work required for this project, with sufficient production capacity to produce and deliver required units without causing delay in work.
- .3 Health and Safety Requirements: worker protection:
  - .1 Protect workers as recommended by CAN/ULC-S705.2 and manufacturer's recommendations:
  - .2 Workers must wear eye protection, gloves, dust masks, long sleeved clothing and respirators when applying foam insulation.
  - .3 Workers must not eat, drink or smoke while applying foam insulation.

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

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location, off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect specified materials from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

#### **1.5 SITE CONDITIONS**

- .1 Ventilate area to receive insulation by introducing fresh air and exhausting air continuously during and 24 hour after application to maintain non-toxic, unpolluted, safe working conditions.
- .2 Provide temporary enclosures to prevent spray and noxious vapours from contaminating air beyond application area.
- .3 Protect adjacent surfaces and equipment from damage by overspray, fall-out, and dusting of insulation materials.
- .4 Apply insulation only when surfaces and ambient temperatures are within manufacturers' prescribed limits.

### **Part 2 Products**

#### **2.1 MATERIALS**

- .1 Insulation: spray polyurethane to CAN/ULC-S705.1.
- .2 Primers: in accordance with manufacturer's recommendations for surface conditions.
  - .1 Maximum VOC limit 100 g/L to GS-11 Standard.

### **Part 3 Execution**

#### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for sprayed insulation application accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Consultant.

- .2 Inform Consultant of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied.

### **3.2 APPLICATION**

- .1 Apply insulation to clean surfaces in accordance with manufacturer's printed instructions and CAN/ULC-S705.2.
- .2 Use primer where recommended by manufacturer.
- .3 Apply sprayed foam insulation in thickness as indicated.

### **3.3 FIELD QUALITY CONTROL**

- .1 Manufacturer's Field Services:
  - .1 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

### **3.4 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
  - .1 Remove insulation material spilled during installation and leave work area ready for application of wall board.

**END OF SECTION**





**Part 1 General**

**1.1 GENERAL**

- .1 Contractor to provide an original, complete insurance policy identifying specific coverage for torch applied systems.

**1.2 RELATED SECTIONS**

- .1 Section 06 10 53 – Miscellaneous Rough Carpentry.
- .2 Section 07 21 16 – Blanket Insulation.
- .3 Section 07 62 00 – Sheet Metal Flashing and Trim.
- .4 Section 07 92 00 – Joint Sealants.
- .5 Section 22 05 11 – Plumbing and Drainage.

**1.3 REFERENCES**

- .1 American Society for Testing and Materials International, (ASTM)
  - .1 ASTM A653/A653M-15, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
  - .2 ASTM C1177/C1177M-13, Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
  - .3 ASTM C1396/C1396M-13, Standard Specification for Gypsum Board.
  - .4 ASTM D4637/D4637M-14e1, Standard Specification for EPDM Sheet Used In Single-Ply Roof Membrane.
- .2 Canadian Standards Association (CSA International)
  - .1 CAN/CGA-8.1-M86 (R2011), Elastomeric Composite Hose and Couplings for Conducting Propane and Natural Gas.
  - .2 CSA A123.3-05, Asphalt Saturated Organic Roofing Felt. (updated)
  - .3 CAN/CSA-A123.4-04 (R2013) - Asphalt for Constructing Built-Up Roof Coverings and Waterproofing Systems.
  - .4 CSA A123.22-08(r2013), Self-Adhering Polymer Modified Bituminous Membrane Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
  - .5 CSA A123.23-15 - Product specification for polymer-modified bitumen sheet, prefabricated and reinforced.
  - .6 CSA A231.1-14/A231.2-14, Precast Concrete Paving Slabs / Precast Concrete Pavers.
  - .7 CSA B149.1-10 (R2015), Natural Gas and Propane Installation Code
  - .8 CSA B272-93 (R2000), Prefabricated Self-Sealing Roof Vent Flashings.
  - .9 CSA O151-09, Canadian Softwood Plywood.
- .3 Canadian General Standards Board (CGSB)

- .1 CAN/CGSB-1.108-M89, Bituminous Solvent Type Paint.
- .2 CAN/CGSB-37.5-M89, Cutback Asphalt Plastic Cement.
- .3 CAN/CGSB-51.33-M89, Vapour Barrier Sheet, Excluding Polyethylene, for Use in Building Construction.
- .4 Factory Mutual (FM Global)
  - .1 Hot Work Permit Form F2630.
  - .2 FM 4450, Approval Standard for Class 1 Insulated Steel Roof Decks.
- .5 Underwriters Laboratories' of Canada (ULC)
  - .1 CAN/ULC-S107-10, Standard Methods of Fire Tests of Roof Coverings.
  - .2 CAN/ULC-S126-06, Standard Method for Test for Fire Spread Under Roof Deck Assemblies.
  - .3 CAN/ULC-S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.
  - .4 CAN/ULC-S702.2-03, Standard for Mineral Fibre Thermal Insulation for Buildings.
  - .5 CAN/ULC-S704-03, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate Boards, Faced.
  - .6 CAN/ULC-S705.1-01, Standard for Thermal Insulation – Spray-Applied Rigid Polyurethane Foam, Medium Density.
  - .7 CAN/ULC-S705.2-05, Standard for Thermal Insulation - Spray-Applied Rigid Polyurethane Foam, Medium Density – Application.
  - .8 CAN/ULC-S770-09, Standard Test Method for Determination of Long-Term Thermal Resistance of Closed-Cell Thermal Insulating Foams.

#### **1.4 ADMINISTRATIVE REQUIREMENTS**

- .1 Convene pre-installation meeting one week prior to beginning roofing Work, with roofing contractor's representative and Consultant to:
  - .1 Verify project requirements.
  - .2 Review installation and substrate conditions.
  - .3 Co-ordination with other building subtrades.
  - .4 Review manufacturer's installation instructions and warranty requirements.

#### **1.5 COORDINATION**

- .1 Coordinate work of this Section with related work specified in other Sections to ensure construction schedule is maintained and water tightness and protection of the building and finished work is maintained at all times.

#### **1.6 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 System summary:

- .1 Provide a one page synopsis of each roof type that lists the assembly components in order from top to bottom.
- .3 Product Data:
  - .1 Provide two copies or an electronic copy of most recent technical roofing components data sheets describing materials' physical properties and include product characteristics, performance criteria, physical size, finish and limitations for all products to be incorporated in the new system.
  - .2 Provide two copies or an electronic copy of WHMIS 2015 Safety Data Sheets to Consultant for:
    - .1 Primers.
    - .2 Sealers.
    - .3 Liquid membrane.
    - .4 Adhesives.
- .4 Provide shop drawings:
  - .1 Indicate sloped insulation layout and details.
  - .2 Provide shop drawing or submittal indicating adhesive pattern specified by adhesive manufacturer for the required wind uplift pressures indicated on the Drawings.
- .5 Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

## **1.7 QUALITY ASSURANCE**

- .1 Installer qualifications: Company or person specializing in application of modified bituminous roofing systems with 5 years documented experience, approved by manufacturer.
- .2 Only certified applicators are permitted to use torch welding equipment.
- .3 Hold a pre-installation meeting prior to the start of roofing works, with the roofing contractor's representative and the Consultant, to review installation conditions particular to this project.
- .4 Roof membrane manufacturer shall delegate a representative to visit the work site at the start of roofing installation. Contractor shall engage membrane manufacturer's technical representative as required to provide technical guidance for and inspection of membrane application. The Contractor shall at all times enable and facilitate access to the worksite by this representative.

## **1.8 FIELD QUALITY CONTROL**

- .1 Water Testing:
  - .1 In the event the Consultant deems any of the Work to be deficient, provide water test of all flashing, projections, equipment on roof and roofing system. Co-ordinate test with the Owner's operations personnel.
  - .2 Contractor is to assume all costs of testing and correction.

.2 Adhesion Testing:

- .1 If requested by the Consultant, at each roof drainage area, following installation of membrane base sheet, carry out adhesion tests to confirm adhesion of membrane to substrate and substrate layers to each other, down to first mechanically attached layer.
- .2 Locations and timing of tests will be directed by Consultant. Provide labour and materials as required to assist Consultant in conducting tests.
- .3 If inadequate adhesion is found, conduct further testing to determine the extent of the inadequate adhesion. Replace all defective areas to the satisfaction of the Consultant. Replace substrate materials as necessary with new materials, and patch cut tests with membrane patches extending at least 150 mm beyond the cut.
- .4 Contractor is to assume all costs of testing and correction.

.3 Sample Testing:

- .1 If requested by the Consultant, at each roof drainage area, following installation of membrane base sheet, carry out sample tests to confirm materials and installation of roof assembly components. Sample size to be 300 mm x 300 mm.
- .2 Locations and timing of tests will be directed by Consultant.
- .3 If inadequate construction is found, conduct further testing to determine the extent of the inadequate adhesion. Replace all defective areas to the satisfaction of the Consultant. Replace substrate materials as necessary with new materials, and patch cut tests with membrane patches extending at least 150 mm beyond the cut.
- .4 Contractor is to assume all costs of testing and correction.

**1.9 FIRE PROTECTION**

.1 Fire Extinguishers:

- .1 Pressure rechargeable type with hose and shut-off nozzle,
- .2 ULC labeled for ABC class protection.
- .3 ULC labeled for A class protection, for wood, paper and fibreboard.
- .4 Size 14 kg.
- .5 Have one fully charged ABC extinguisher and one fully charged Type A extinguisher on roof per torch applicator, within 3 m of the propane source.

- .2 Maintain fire watch for 2 hours after each day's torching operations cease.

**1.10 GENERAL REQUIREMENTS**

- .1 Comply with the General Requirements, General Instructions and Supplementary Conditions.

- .2 Execute work in accordance with this Section and other related Sections, Drawings and Details.
- .3 Attach roofing to structure to meet requirements of insurance underwriter and authorities having jurisdiction.
- .4 Regard manufacturer's printed recommendations as minimum requirement for materials, methods and workmanship not otherwise specified.
- .5 Contact the Consultant if the specifications conflict with the manufacturer's recommendations. Otherwise it will be assumed that the Contractor and manufacturer are in agreement with procedures outlined.
- .6 Advise the Consultant of adjustments to specified roofing procedures caused by weather and site conditions. Make adjustment to specified procedures only after review with the Consultant.
- .7 Maintain equipment in good working order to ensure control of roofing operations and protection of work. Types of roofing equipment and laying techniques to be employed are to meet the approval of the Consultant.
- .8 Do not penetrate roof deck with any fastening devices that would do damage or impair the function of the assembly or of any interior service.
- .9 All temporary drains shall be connected with a mechanical connection (MJ coupling) or a U-flow connection, until new drains are installed.

#### **1.11 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Safety: Comply with requirements of Workplace Hazardous Materials Information System (WHMIS 2015) regarding use, handling, storage, and disposal of, sealing compounds, primers and caulking materials.
- .3 Manufacturer's recommendations for handling and storing products are to be considered a minimum requirement.
- .4 Materials shall be delivered to the site, undamaged and in their original packages, with manufacturer's labels visible, attesting to their conformity to specific standards.
- .5 Ensure that shelf life of materials has not expired.
- .6 Remove damaged material from site and replace all rejected materials with new product.
- .7 Elevate on raised platform and store as to prevent deformation of materials.
- .8 Provide and maintain dry, off-ground weatherproof storage.

- .9 Store rolls of membrane in upright position. Store membrane rolls with selvage edge up.
- .10 Remove only in quantities required for same day use.
- .11 Place plywood runways over completed Work and over areas not in Contract, as required, to enable movement of material and other traffic.
- .12 Store sealants at +5°C minimum.
- .13 Protect insulation by slitting manufacturer's packaging and installing a waterproof UV-resistant tarp.
- .14 Handle roofing materials in accordance with manufacturer's written directives, to prevent damage or loss of performance.
- .15 Avoid stockpiling of materials or use of equipment on decks in a way which could cause overloading.

#### **1.12 ENVIRONMENTAL REQUIREMENTS**

- .1 Ensure protection of products that are sensitive to damage by moisture. Do not work during rain, snow or fog. Stop work and make watertight before the onset of inclement weather or when weather appears imminent.
- .2 Ensure protection of the building from weather at all times. If inclement weather is forecast or appears imminent, postpone work that would risk the building from moisture damage.
- .3 If it becomes apparent that work would threaten the building watertightness, the Owner has the right to stop work. Any additional expenses due to work stoppage or postponement of work will be at the Contractor's expense.
- .4 Ambient Conditions
  - .1 Do not install roofing when ambient temperature remains below -18°C for torch application.
  - .2 Minimum ambient temperature for solvent-based adhesive is -5°C.
- .5 Install roofing on dry deck, free of snow and ice, use only dry materials and apply only during weather that will not introduce moisture into roofing system.

#### **1.13 COMPATIBILITY**

- .1 Compatibility between materials is essential. Use only materials that are known to be compatible when incorporated in a complete assembly. Provide written declaration to Consultant stating that materials and components, as assembled in system, meet this requirement.
- .2 Defective work resulting from work with incompatible materials will be considered the responsibility of the Contractor.

- .3 Repair all work that could result in damage or interfere with performance.

#### **1.14 EXISTING SUBSTRATES**

- .1 Following removal of existing material to the substrate, inspect the deck for soundness and notify the Consultant of any deck found unsound and not suitable for roofing. Do not commence work until conditions are documented and the Consultant rules on the acceptability of surfaces and/or corrective measures required. The cost of any delays due to postponement of work that results from investigating the site problem or obtaining a ruling will be at the Owner's expense.
- .2 The commencement of work is proof that the Contractor has accepted surfaces as satisfactory and accepts responsibility for appearance and performance of completed work.
- .3 Defective work resulting from application of material on unsatisfactory surfaces will be considered the responsibility of the Contractor.
- .4 The Contractor will be responsible for all repairs, costs and pay all cost and fees required to rectify damage or defective work. Use materials and finish to match the original preconstruction conditions.

#### **1.15 DAILY OPERATIONS**

- .1 Unless otherwise specified, complete the entire roofing operation up to line of termination of each day's work, as required by design intent, in order to safeguard and protect the work and building from damage and weather.

#### **1.16 EXAMINATION**

- .1 Before proceeding with roofing application, ensure that:
  - .1 All surfaces are clean and free of debris, snow, frost and moisture.
  - .2 The deck is clean and sufficiently dry to ensure specified adhesion will be obtained.
  - .3 Adjacent construction and installation of related work (i.e. curbs, drains, penetrations, wood nailers, etc.) incorporated with the roof are complete.
  - .4 Roof deck is sound, existing fasteners are tight and irregularities are corrected to provide a suitable surface for new roofing.
- .2 Ensure substrate is smooth. Remove sharp edges or protrusions that could impair the function of the roof assembly.
- .3 Inform Owner/Consultant in writing of any defects.

#### **1.17 DRAINS AND DRAINAGE PLANE**

- .1 Inspect surfaces and ensure that roof deck is level or sloped to drains in conforming to design intent.

- .2 Inspect surfaces and ensure that roof drains are set at a level to drain and are connected or capped.
- .3 Take spot levels to verify that pools of water in excess of 13 mm depth will not form.
- .4 Tabulate levels and submit to Consultant.
- .5 Ensure plumbing is accessible and work can be completed as specified.
- .6 Inspect roof drains to ensure they are open and working properly.
- .7 Where specified or shown for areas with only one drain, provide overflow scuppers or drains to detail and specified requirements.

#### **1.18 EXAMINE UNDERSIDE OF DECK**

- .1 Inspect the underside of deck to ensure fasteners will not damage the structure, affect interior surfaces or electrical and mechanical services.
- .2 For drain alterations and pipe hangers, coordinate with plumbing subtrade as per Section 22 05 11 – Plumbing and Drainage, prior to commencement of roofing operations.

#### **1.19 HIDDEN SERVICES**

- .1 Investigate the location of all known hidden services by reviewing interior conditions, plans, specifications and drawings for the original building, any subsequent alterations, completion of cut tests and interviewing those involved in the construction and maintenance of building services. These services include but are not limited to mechanical, electrical, cable, communication, computer, security or roof assembly. Ensure all services are located and will be protected from damage under the Contract. In some cases, services may be located over the roof deck and within the roof assembly. Notify Owner/Consultant in such occurrence and proceed with installation as directed.

#### **1.20 EQUIPMENT**

- .1 Inspect equipment affected by the work, including but not limited to rooftop equipment, curbs, existing drains and plumbing, mechanical, electrical and lightening protection services, to ensure they are in good repair and working order. Record any damage and advise the Consultant.
- .2 During re-roofing, ensure that all mechanical equipment, ducts, pipes, etc. are properly supported.
- .3 Notify Owner and/or Consultant of any equipment which is not operational or damaged prior to the commencement of work.



**1.21 ADVISE CONSULTANT**

- .1 Advise the Consultant of any unusual circumstances affecting the work. Notify the Consultant of any defective or malfunctioning equipment or drainage deficiencies. Do not commence work until defects and incorrect levels have been verified and rectified.

**1.22 PROTECTION OF ROOFTOP EQUIPMENT**

- .1 Remove any equipment and flashing intended for re-use and save from harm. Store in approved location and reset at project conclusion unless specified or shown to be removed.
- .2 Protect all openings, vents and stacks from weather and contamination from debris.
- .3 Provide temporary plumbers plugs to protect drains during roofing operations. Ensure that temporary protection is removed at completion of work period and/or at the end of each days work.

**1.23 SERVICES**

- .1 Services are to be left operational unless otherwise authorized by the Owner.
- .2 Unless otherwise specified, the Contractor will be responsible for disconnection, relocation, re-installation and extending all services required to facilitate work under this Contract. Co-ordinate work with the Owner and provide minimum of 48 hours notification if services are to be interrupted.
- .3 Contractor to verify location of services prior to commencement of work. Notify Owner/Consultant of any unusual conditions.
- .4 The Contractor and their employees must hold valid certificates for the work undertaken.
- .5 Complete work of this Section as required by local authorities having jurisdiction. Have work inspected and pay all fees relative to such inspection to ensure work meets with published standards and codes.
- .6 Submit Certificate or Letter of Approval by authority responsible for the work to the Owner and Consultant with final documentation.
- .7 All fans, air handling units, and any electrical equipment affected by the replacement of the roof sections under this Section, whether disconnected or extended must be inspected by an ESA representative to verify the integrity of the existing wiring and/or the new installation.

**1.24 WARRANTY**

- .1 Contractor's Warranty for Labour and Material:

- .1 For Work of this Section 07 52 00 - Modified Bituminous Membrane Roofing, and all associated roofing work, the 12 months warranty period is extended to 60 months.
  - .2 Make all necessary repairs and replacements within 48 hours of receipt of written notification.
  - .3 Nothing contained in this Article shall be construed as in any way restricting or limiting the liability in common law and statutory liability of the Contractor.
  - .4 Provide these written warranties, confirming above, issued on the corporate letterhead, signed and sealed by an authorized signing officer. The warranties will specifically reference the name of the building, address and the name of the owner.
- .2 Manufacturer's Warranty:
- .1 Provide a 15-year full system warranty.
  - .2 The contractor is to ensure all materials selected for use on the project are in full compliance with the terms and conditions of the manufacturer's warranty requirements.

## **Part 2 Products**

### **2.1 GENERAL**

- .1 All standards, regulations and specifications listed herein are considered to be the latest available edition.
- .2 All materials are to be supplied in compliance with system manufacturer warranty requirements. Acceptable system manufacturers:
  - .1 Soprema.
  - .2 IKO Industries Ltd.
  - .3 Henry Bakor.
  - .4 Johns Manville.

### **2.2 ROOF DECK SHEATHING MATERIALS**

- .1 Glass mat gypsum sheathing: Glass mat faced treated core gypsum roof board, for installation over steel deck to ASTM C1177/C1177M. Boards to be 1.2 m x 2.4 m, thickness as indicated, with pre-primed surface where indicated.
  - .1 Standard of acceptance:
    - .1 DensDeck Roof Board by GP Gypsum.
    - .2 Securock by USG.
    - .3 Or accepted alternate.

### **2.3 PRIMERS**

- .1 Asphalt Primer: To manufacturer's recommendations.

- .2 Self-adhesive membrane primer. As recommended by membrane manufacturer. Use low VOC, polymer emulsion-based primer, unless directed otherwise by Consultant on site.

## **2.4 AIR/VAPOUR BARRIER MEMBRANE**

- .1 For torchable gypsum board surfaces:
  - .1 Torch grade styrene-butadiene-styrene (SBS) to CSA A123.23, with polyester or glass fleece reinforcement, minimum thickness 3.5 mm, top side sanded.
    - .1 Type A, B or C.
    - .2 Grade 3.
    - .3 Top and bottom surfaces: sanded top surface and thermofusible plastic film bottom surface.

## **2.5 SELF-ADHERED MEMBRANE**

- .1 Self-adhered membrane: To CSA A123.22, self-adhering membrane consisting of SBS rubberized asphalt compound laminated to a polyethylene film. Minimum thickness 1 mm.
  - .1 Standard of acceptance:
    - .1 Lastobond Shield HT by Soprema.
    - .2 PE200HT by Henry.
    - .3 AquaBarrier™ AVB by IKO.

## **2.6 MEMBRANE AND MEMBRANE FLASHINGS**

- .1 Base sheet membrane (non-combustible substrates): Torch grade styrene-butadiene-styrene (SBS) to CSA A123.23, with polyester or glass fleece reinforcement, minimum thickness 3.0 mm.
  - .1 Type B or Type C.
  - .2 Grade 3.
  - .3 Top surfaces: Thermofusible plastic film.
  - .4 Bottom surfaces: Thermofusible plastic film.
- .2 Self-adhesive base sheet membrane flashing (combustible substrates): styrene-butadiene-styrene (SBS) to CSA A123.23, with polyester or glass fleece reinforcement and release paper, minimum thickness 3.0 mm.
  - .1 Type B or Type C.
  - .2 Grade 2.
  - .3 Top surfaces: Thermofusible plastic film.
  - .4 Bottom surfaces: Self-adhesive with release paper.

- .3 Cap sheet membrane and membrane flashing: Torch grade styrene-butadiene-styrene (SBS) to CSA A123.23, with polyester or glass fleece reinforcement, minimum thickness 4.0 mm.
  - .1 Type B or Type C.
  - .2 Grade 1, granule surfaced. Colour for granular surface: brown.
  - .3 Grade 1, standard service.
  - .4 Bottom surface thermofusible plastic film.
- .4 Fireguard tape:
  - .1 Modified bituminous membrane supplied in strips, 150 mm wide, 1.6 mm thick, glass fleece reinforced with self-adhesive underside.
  - .2 Provided by membrane manufacturer.

## **2.7 LIQUID MEMBRANE**

- .1 Two-component methacrylate or one component polyurethane/bitumen resin, solid content 80% or greater, compatible with roof membrane.
  - .1 Standard of acceptance:
    - .1 Alsan Flashing by Soprema.
    - .2 MS Detail by IKO.
    - .3 PermaFlash by Johns Manville.
    - .4 Or accepted alternate.
- .2 Reinforcement mesh: As recommended by liquid membrane manufacturer.

## **2.8 ADHESIVES**

- .1 Adhesive for securing overlay board and insulation: To be fully compatible with all materials in the roofing assembly. Applicability of use to adhere the different materials in the roofing assembly to be included in the manufacturer's literature.
  - .1 Standard of acceptance:
    - .1 Duotack by Soprema.
    - .2 Millenium by IKO.
    - .3 Fas-n-free by Tremco.
    - .4 Insta-Stick by Instafoam Inc.
    - .5 Roof Assembly Adhesive by Chemlink.
    - .6 Olybond 500 by OMG.
    - .7 2-Part UIA by Johns Manville.
    - .8 Or accepted alternate.

## **2.9 POLYISOCYANURATE INSULATION (INORGANIC)**

- .1 Conforming to CAN/ULC S704, rigid foam board, Class 2 or 3, Type 3. Manufactured with HC blowing agent meeting requirements of CAN/ULC S126, CAN/ULC S107 and CAN/ULC S770 for LTTR values. Approved and listed by Factory Mutual Global for 1-60 and 1-90 wind classification and FM 4450 requirements for Class 1 fire. Thickness as specified or shown with maximum

board size 1200 mm x 1200 mm. Fibre-reinforced **inorganic facers** on both major surfaces of the core foam.

## **2.10 TAPERED INSULATION (INORGANIC)**

- .1 Conforming to CAN/ULC S704, rigid foam board, Class 2 or 3, Type 3. Manufactured with HC blowing agent meeting requirements of CAN/ULC S-126, CAN/ULC S107 and CAN/ULC S770 for LTTR values. Approved and listed by Factory Mutual Global for 1-60 and 1-90 wind classification and FM 4450 requirements for Class 1 fire. Thickness as specified or shown with maximum board size 1200 mm x 1200 mm. Fibre-reinforced **inorganic facers** on both major surfaces of the core foam.
- .2 Insulation slopes shall be as indicated on the detailed drawings and roof plans. Modules shall be factory cut to correct slopes.
- .3 Sloped insulation must terminate at 0 thickness. Supply an additional nosing piece if required, factory fabricated of compatible, flame-resistant sloped rigid insulation material, to smoothly terminate sloped insulation at 0 thickness.

## **2.11 OVERLAY BOARD**

- .1 Overlay board: 6 mm thick asphalt based overlay board with non-woven glass facers, as recommended by the membrane manufacturer.

## **2.12 SEMI-RIGID MINERAL WOOL INSULATION**

- .1 To Section 07 21 16, Blanket Insulation.

## **2.13 SPRAYED POLYURETHANE INSULATION**

- .1 To Section 07 21 29.03, Sprayed Insulation - Polyurethane Foam

## **2.14 SEALERS**

- .1 Plastic cement: Asphalt, to CAN/CGSB-37.5.
- .2 For sealants, mastic, adhesives or caulk, refer to Section 07 92 00 – Joint Sealants.

## **2.15 WALKWAY MATERIALS**

- .1 Walkways are to be composed of each of the following materials:
  - .1 One additional ply of sacrificial cap sheet membrane.
  - .2 Rubber protection pad.
  - .3 Concrete pavers.

## **2.16 PROTECTION MATERIALS**

- .1 Rubber protection pad: Heavy duty grade, 550 mm x 550 mm, 8 mm thick, masticated recycled rubber with reinforcement and UV resistant, dimpled surface.

## **2.17 MEMBRANE FASTENING BAR**

- .1 Galvanized sheet steel or extruded aluminum, thickness 1 mm (20 ga.), 38 mm width, supplied in minimum 2.4 m lengths, with pre-drilled 2 mm holes, secured with #14 stainless steel screws @ 150 mm c/c.

## **2.18 FASTENERS**

- .1 Fasteners for gypsum board to steel deck: No. 12 flat head, self-tapping, Type A or AB, cadmium plated screws. Use fastener plates (see below).
- .2 Fastener plates: FM Global approved 75 mm hexagonal metal plates, 75 mm hexagonal plastic lock plates.
  - .1 Standard of acceptance: Dekfast or Consultant approved alternative.
- .3 Fasteners for exposed metal flashing and cladding to wood or steel: Minimum 38 mm #10 cadmium plated hex head screws, colour matched, with neoprene and steel washers.
- .4 Fasteners for sheet metal into steel: Self-drilling, self-tapping screws, galvanized, #8 or larger size, Tekes or equivalent, head to suit application.
- .5 Fasteners for sheet metal and wood to wood: Corrosion resistant #10 wood screws or nails to suit application.
- .6 Structural fasteners into wood: Lag screws, 12.7 mm diameter hot dipped galvanized steel, length 125 mm.

## **2.19 PLUMBING VENTS**

- .1 Spun aluminum flashing consisting of metal flashing sleeve with integral flange, matching aluminum hood, perforated collar premoulded urethane insulation liner and EPDM base seal. Diameter to suit existing pipe size.
  - .1 Standard of acceptance: SJ-31 Vandal Proof Stack Jack Flashings as manufactured by Thaler, or Consultant approved alternative.

## **2.20 SPLIT FLASHING FOR PIPE PENETRATION**

- .1 Fabricated from 0.48 mm (26 ga.) Type 304, stainless steel, compliant with CSA B272, 2-piece, with EPDM triple pressure grommet seal around cap and continuous EPDM seals at split junctures of sleeve and deck flange, with stainless steel bolted closure design, size to suit structure, 450 mm in height.
  - .1 Standard of acceptance: SPJ-1 by Thaler, or Consultant approved alternative.

## **2.21 CONDUIT PENETRATION FLASHING**

- .1 Consists of metal flashing sleeve with bent integral flange, pre-molded urethane insulation liner, EPDM triple pressure grommet seal & EPDM base seal.
  - .1 Material: Aluminum
  - .2 Standard of acceptance: MEF-2A by Thaler, or Consultant approved alternative.

## **2.22 B-VENT BASE FLASHING AND STORM COLLAR**

- .1 Rain collar to be shop fabricated from 0.61 mm (24 ga.) galvanized sheet, to be same material as base flashing, 100 mm girth, with integral tightening clamp.

## **2.23 CONCRETE PAVERS**

- .1 Concrete pavers: To CSA A231.1, 600 x 600 x 50 mm thick of sizes indicated natural, air entrained precast concrete paving slabs having non-slip finish with 51 mm plain margin around perimeter.

## **2.24 PREFABRICATED INSULATED ROOF CURB**

- .1 Prefabricated roof curb to be manufactured of prime galvanized steel construction, 1.2 mm (18 ga.) steel thickness, meeting ASTM A653/653M, with welded corners and with seams joined by continuous water and airtight welds. Roof curb shall be internally reinforced with angles 600 mm on center and factory installed wood nailer. Internally insulated with 38 mm thick 0.53 kN/m<sup>3</sup> (3 pcf). density rigid insulation. Heights to be as detailed to suit installed roof thickness. Top of all roof curbs shall be level, with pitch built into curb when deck slopes.

## **2.25 ROOF ACCESSORIES**

- .1 Miscellaneous clamps: For extending gas piping services to CAN/CGA-8.1-M86.
- .2 Bituminous metal paint: To isolate metal from concrete and masonry surfaces, to CAN/CGSB-1.108-M89 Type II.
  - .1 Standard of acceptance: 810-07 by Henry Inc. or Consultant approved alternative.
- .3 Pile weatherstripping: Vinyl and pile, external attachment to door sill, adjustable.

## **Part 3 Execution**

### **3.1 QUALITY OF WORK**

- .1 Do examination, preparation and roofing Work in accordance with Roofing Manufacturer's Specification Manual and CRCA Roofing Specification Manual.
- .2 Do priming in accordance with manufacturer's written recommendations.
- .3 Fit the interface of all walls and roof assemblies with durable rigid material sheet metal or plywood providing connection point for continuity of air barrier.

- .4 Make assembly, component and material connections in consideration of appropriate design loads, with reversible mechanical attachments.
- .5 In the event that any product contains a manufacturing defect or anomaly, the Contractor shall notify the Consultant and manufacturer immediately and request direction.

### **3.2 REMOVAL OF EXISTING ROOFING**

- .1 Remove all roofing, flashing and insulation materials down to deck. Leave existing blocking and parapet construction in place where indicated. Where a built-up air/vapour barrier is present, remove this from the deck unless agreement is otherwise obtained from the Consultant to leave in place.
- .2 Remove existing rooftop equipment where indicated.

### **3.3 EXAMINATION OF ROOF DECKS**

- .1 Verification of Conditions:
  - .1 Inspect with Consultant deck conditions including parapets, construction joints, roof drains, plumbing vents and ventilation outlets to determine readiness to proceed.
- .2 Evaluation and Assessment:
  - .1 Prior to beginning of work ensure:
    - .1 Decks are firm, straight, smooth, dry, free of snow, ice or frost, and swept clean of dust and debris. Do not use calcium or salt for ice or snow removal.
    - .2 Curbs have been built.
    - .3 Roof drains have been installed at proper elevations relative to finished roof surface.
    - .4 Plywood and lumber nailer plates have been installed to deck, walls and parapets as indicated.
- .3 Do not install roofing materials during rain or snowfall or when such weather is imminent.

### **3.4 MECHANICAL EQUIPMENT DISCONNECTION / MODIFICATION / RECONNECTION**

- .1 Perform disconnection, extension, modification, and reconnection of mechanical equipment in accordance with drawings provided. Work shall be performed by a licensed trade sub-contractor. Obtain approval from Consultant prior to making adjustments not scheduled.
- .2 In general, Contractor is responsible for disconnection extension, modification, and reconnection of all operating HVAC equipment in work area. Owner is responsible for disconnection (at interior) of those mechanical items indicated for removal by Contractor.



- .3 All mechanical equipment must be properly tagged out of service (especially where gas is present). ESA certificates are required for all mechanical and electrical reconnections.

### **3.5 PROTECTION OF IN-PLACE CONDITIONS**

- .1 Cover walls, walks and adjacent work where materials hoisted or used.
- .2 Use warning signs and barriers. Maintain in good order until completion of Work.
- .3 Protect roof from traffic and damage. Comply with precautions deemed necessary by Consultant.
- .4 At end of each day's work or when stoppage occurs due to inclement weather, provide protection for completed Work and materials out of storage.
- .5 Metal connectors and decking will be treated with rust proofing or galvanization.
- .6 Fit the interface of the walls and roof assemblies with durable rigid material sheet metal or plywood providing connection point for continuity of air barrier.

### **3.6 PRIMING**

- .1 Unless otherwise indicated or directed by Consultant, prime all surfaces which will be in direct contact with bituminous materials at the rate of 0.15 L/m<sup>2</sup> to manufacturer's recommendations. For self-adhering membrane, install primer at a rate recommended by manufacturer. Ensure that surfaces are tack-free before proceeding.
- .2 Limit quantity of primer at deck openings and points of termination and provide supplemental protection to prevent bleedthrough to the building interior.
- .3 Roll primer into surface.
- .4 Re-prime all surfaces, including pre-primed surfaces, that become contaminated with dust or become marred due to their exposure to roof traffic or weather.

### **3.7 INSTALLATION OF GYPSUM BOARD SHEATHING**

- .1 Attach boards as per the OBC Wind Uplift Attachment detail illustrated on the drawings.
- .2 Install boards as detailed and specified with primed or top side up.
- .3 Over steel deck, place with long axis of each sheet transverse to steel deck ribs with end joints staggered and fully supported on ribs.
- .4 Cut sheets as required to suit site conditions.
- .5 Butt joints tightly. Use maximum size pieces where possible to reduce joints.

### **3.8 MECHANICAL FASTENERS FOR SHEATHING (STEEL DECK)**

- .1 Attach boards as per the OBC Wind Uplift Attachment detail illustrated on the drawings.
- .2 In compliance with specified requirements, use mechanical fasteners to secure boards in place.
- .3 Inspect the underside of the deck to ensure fasteners will not be visible, damage the structure or interior surfaces, affect electrical and mechanical services. Fasteners to penetrate top flute of the deck maximum 20 mm.
- .4 Advise Consultant of any unusual circumstances affecting the work. Be responsible and correct all damage caused by work to match existing materials and finish.
- .5 Secure to top flute of steel deck with screws spaced in pattern specified. Use screw-type anti-backout corrosion resistant fasteners with 75 mm metal plates as generally approved or required by the fastener manufacturer.
- .6 Prime metal plates that will be covered with bitumen roofing. Ensure primer is tack-free before proceeding.

### **3.9 AIR SEALS**

- .1 Install 0.56 mm (26 ga.) galvanized or 0.51 mm (26 ga.) pre-finished metal air seal where indicated. Mechanically secure metal to deck and extend as required to allow a minimum 100 mm tie-in with air/vapour barrier membrane. Lap and seal air/vapour barrier membrane onto air-seal.

### **3.10 TORCH-APPLIED AIR/VAPOUR BARRIER ON SHEATHING**

- .1 Ensure all surfaces to be covered with self-adhering membrane are complete and free of moisture and contaminants and surfaces are above 5°C (40°F). At temperatures below 5°C (40°F) heat materials to be covered with hot air gun. Store all materials in heated storage when temperatures fall below 5°C (40°F) and remove only as much material that can be used before cooling.
- .2 Prime all vertical surfaces to be covered with torch-applied membrane, and horizontal surfaces as required. Use roller application – no spray application permitted. Let primer tack dry and complete thumb test to test set-up.
- .3 Use fireguard tape or overlay board to protect all joints in substrate and all combustible surfaces.
- .4 Working up slope from drain, install air/vapour barrier membrane using torch methods, true to line to completely cover the area intended to be protected to points shown on the drawing.
- .5 Membrane is to be installed without air blisters and wrinkles. Rework, repair or replace all poorly installed membrane. Do not stretch material that would result in pullback and deformity of the membrane at intersections.

- .6 Lap all side laps 75 mm and end laps 150 mm. Torch all seams to achieve bleedout. At nailable surfaces, secure all membrane on vertical surface at points of termination at 150 mm c/c, using large head roofing nails.
- .7 Turn up membrane 150 mm at edge where horizontal surface meets vertical planes. Lap onto existing surfaces as required to provide continuity of air/vapour barrier at terminations. Use fireguard tape or overlay board to protect all open joints in deck and all combustible surfaces
- .8 Seal all points of termination at horizontal planes and vertical surfaces with modified sealant. Tool sealant to consistent smooth and even surface.
- .9 Seal all perimeters and penetrations, and ensure drains are operational and prevent backflow, if air/vapour barrier is to be left exposed as an overnight temporary waterproofing.

### **3.11 INSULATION – ALL LAYERS – ADHESIVE ADHERED**

- .1 Attach insulation as per the OBC Wind Uplift Attachment detail illustrated on the drawings.
- .2 Install base insulation layer over air/vapour barrier to specified design intent and thickness. Secure insulation laid with adhesive, in pattern as per adhesive manufacturer's directions and as indicated. Apply boards before adhesive cures, skims over or loses adhesive qualities.
- .3 For subsequent layers of insulation, secure insulation laid with adhesive, in pattern as per adhesive manufacturer's recommendations and as indicated.
- .4 Stagger all joints of insulation a minimum 300 mm.
- .5 Stagger both end and side joints between insulation layers.
- .6 Butt sheets of insulation with moderate contact. Do not force insulation into place. Cut neatly at projections and points of termination. Replace all broken, damaged or misfit boards as work progresses.
- .7 Where necessary, back-cut insulation to allow it to conform and stay bonded to irregular surfaces without bridging. Subsequent to placement, walk insulation into place to ensure positive bonding is achieved.

### **3.12 TAPERED INSULATION**

- .1 Attach boards as per the OBC Wind Uplift Attachment detail illustrated on the drawings.
- .2 At all locations of tapered insulation provide shop drawings from sloped insulation manufacturer for Consultant's review prior to installation.
- .3 At all new and existing drain locations, provide tapered polyisocyanurate insulation sump around drain to promote positive drainage. Total sump size to be

as shown on drawings, with maximum depression of 25 mm, unless otherwise indicated.

- .4 Installation methods for tapered insulation to be same as for upper layers of base insulation, using adhesive as specified.
- .5 At the low termination of tapered insulation, when applying overlay board, Contractor shall increase adhesive application by adding 4 additional ribbons at 100 mm spacing at the 13 mm elevation change from tapered to flat insulation, to compensate for the 13 mm elevation change of tapered insulation.

### **3.13 OVERLAY BOARD**

- .1 Attach boards as per the OBC Wind Uplift Attachment detail illustrated on the drawings.
- .2 Adhere overlay board to insulation with adhesive at the rate and pattern specified, as for insulation.
- .3 Place boards in parallel rows with end joints staggered. Tape joints in overlay board with fireguard membrane where combustible surfaces are directly below.
- .4 Where overlay board is specified on nailable vertical surfaces, secure overlay board using large-head roofing nails at 200 mm centres each direction and tape all joints with fireguard tape.

### **3.14 MODIFIED BITUMINOUS MEMBRANE - GENERAL APPLICATION**

- .1 Inspect and seal all substrates to eliminate fire hazard. Use fireguard tape as required or recommended by manufacturer.
- .2 Mechanical spreaders are not permitted to install modified membranes.
- .3 Use only bitumen, sealants, adhesive or mastics as specified by membrane manufacturer. Provide written approval from manufacturer when proposing any alternatives or substitutions.
- .4 Lay out all sheets as to allow them to relax a minimum of 30 minutes. When temperatures are below 4.4°C keep and lay out rolls in heated storage. Install rolls before temperature fallback of the sheet occurs.
- .5 Roof membrane to be installed in one sheet if possible.
- .6 Lay all membrane starting at low point to ensure that seams do not face water flow. Roll all membrane into place, true to line, free of buckles, air pockets, fishmouths and tears.
- .7 Overlap all end laps minimum 150 mm and side laps 75 mm.
- .8 Offset all side laps between plies by 50%.
- .9 Offset all end laps between plies minimum 1200 mm.

- .10 At valley locations, run membrane continuously with the slope of the main roof. Lay out all sheets to ensure minimum side laps are maintained through valley area and short section of roof beyond. At these locations the side laps for the main roof will increase. Install membrane to details and Consultant's direction onsite.
- .11 Ensure that a watertight seal is achieved at all overlaps and points of termination.
- .12 Carry base sheet flashing over face of building as shown on the drawings.
- .13 Carry membrane up all vertical surfaces to point shown. Cut off corners at 45° at end laps to be covered by the next roll prior to installation of following sheet.
- .14 Verify procedure with Consultant on site. Seal fasteners through membrane immediately with Type 'A' sealant.
- .15 Do not walk on membrane during applications and until sufficient cooling has taken place as to allow for traffic without doing damage or marking surface.

### **3.15 BASE SHEET (TORCH APPLICATION)**

- .1 Install 1-ply base sheet membrane running with the roof slope, starting at the low point. Layout roll in place to verify alignment and proper overlap and re-roll prior to torching.
- .2 Fully torch in place base sheet membrane using proper application techniques as specified by membrane manufacturer.
- .3 Install membrane true to line and free of wrinkles, air pockets, voids, excessive bitumen flow or other irregularities. Ensure the membrane is not overheated at any location. Should any of these conditions occur, immediately stop membrane application and correct the deficiency before proceeding. Notify Consultant and obtain his approval for proposed repair methods. Questionable areas will require to be cut out and replaced.
- .4 Ensure that a watertight seal of all membrane joints and points of termination is achieved with a torch and trowel.
- .5 Terminate base sheet up all verticals 50 mm, secure on vertical with membrane fastening bar and fasteners @ 150 mm c/c.
- .6 Review base membrane for low areas (ponding) and correct with additional base sheet membrane.

### **3.16 BASE SHEET FLASHINGS (SELF-ADHERED APPLICATION)**

- .1 All flashings to be cut across the roll in 1 m sections. Cut off corners at end laps to be covered by next flashing piece.
- .2 Provide chalk lines and install all membrane true to line. Install gusset reinforcement pieces at all corner locations.

- .3 Ensure wall or eave surfaces are clean and dry, free of contaminants or other irregularities. Re-prime as necessary.
- .4 Commence flashings from the drain or low points and overlap all side laps minimum 75 mm. Base sheet flashings to extend 100 mm onto roof surface and terminate as shown in drawings.
- .5 Place sheet into primer or adhesive and press into place using hand roller to ensure uniform adhesion. Use hot air welder on all seams and joints to ensure a waterproof seal on all points of termination. Apply flashings free of air pockets, voids, wrinkles or fishmouths.
- .6 Prior to the application of cap sheet membranes, secure vertical surfaces of base sheet membrane flashings using fasteners and stress plates secured at minimum 300mm centres. Fasteners are to be covered with 150mm x 150mm membrane reinforcement patch centred on fastener.

### **3.17 CAP SHEET (TORCH APPLICATION)**

- .1 Prior to installation, unroll the cap sheet and check for granular embedment width and alignment.
- .2 Layout membrane to ensure side lap of cap sheet does not occur within 150 mm of roof drain.
- .3 Install specified cap sheet membrane running with the roof slope, starting at the low point. Layout roll in place to verify alignment and proper overlap and re-roll prior to torching. Offset cap sheet side laps 50% to base sheet side laps, ensure lap does not lie within 150 mm of a roof drain.
- .4 Install 1-ply cap sheet membrane full torched in place using proper application techniques as specified by the membrane manufacturer.
- .5 Install membrane by softening both contact surfaces simultaneously with recommended torching equipment. During application, unroll membranes slowly into fluid bitumen ensuring consistent 3 mm to 6 mm flow protrudes each side of the roll.
- .6 Install membrane true to line and free of wrinkles, air pockets, voids, excessive bitumen flow or other irregularities. Ensure the membrane is not overheated at any location. Should any of these conditions occur, immediately stop membrane application and correct the deficiency before proceeding. Notify Consultant and obtain his approval for proposed repair methods. Questionable areas will require to be cut out and replaced
- .7 Using a torch and trowel, embed granules at end laps and where required on surface of cap sheet to ensure proper bonding of membrane overlaps.

### **3.18 CAP SHEET FLASHINGS (TORCH APPLICATION)**

- .1 All flashings to be cut across the roll in 1 m sections. Cut off corners at end laps to be covered by next flashing piece.

- .2 Provide chalk lines and install all membrane true to line. Install base sheet gusset reinforcement at all corner locations.
- .3 Commence flashings from the drain or low points and overlap all side laps minimum 75 mm. Cap sheet flashings to extend 150 mm onto roof surface and terminate as shown in drawings. At wall locations, unless otherwise specified, cap sheet flashings to extend up 50 mm higher than base sheet flashings.
- .4 Where required by Summary of Work and details, install 50 mm wide continuous strip of Type 'A' sealant to the tops of parapets or eaves to prevent bitumen spillage on the building exterior.
- .5 Install membrane by softening both contact surfaces simultaneously with recommended torching equipment. During application, unroll membrane slowly into fluid bitumen ensuring consistent 6 mm flow protrudes each side of the roll.
- .6 Unroll and work sheet into place using torch, trowel and wet sponge to ensure proper placement and adhesion.
- .7 Install membrane true to line and free of wrinkles, air pockets, voids, excessive bitumen flow or other irregularities. Ensure the membrane is not overheated at any location. Should any of these conditions occur, immediately stop membrane application and correct the deficiency before proceeding. Notify Consultant and obtain his approval for proposed repair methods. *Questionable* areas will require to be cut out and replaced.
- .8 Touch up bare spots, corners, scuffs and bleedout runs on cap sheet with granules matching membrane colour, immediately following installation. Use hot air welder, torch or Type 'A' sealant to adhere granules to sheet.

### **3.19 DRIP FLASHINGS**

- .1 Follow manufacturer's recommendations as to whether pre-finished flashings built into the roof are to be primed. When primer is required, prime top and underside of all drip flashings to be incorporated with roofing prior to application. Primer must be compatible with both membrane and finishes on pre-finished flashing material. Use primer supplied by the membrane manufacturer. All primer to be dry before proceeding.
- .2 Fabricate and install metal drip flashings built into the roof at locations noted on the drawings as per detail and Section 07 62 00 - Sheet Metal Flashing and Trim. Join flashing with S-lock on face and overlap horizontal joints 50 mm. Mitre and seal inside and outside corners of roof flanges. Seal all overlaps, apply sealant Type 'B' as metal flashing is being installed and clean off any material exposed to view. Avoid contact between caulking and bitumen products.
- .3 Install drip flashing true to line set on top of completed base sheet membrane roofing in continuous strip of Type 'A' sealant. Secure flashings with roofing nails installed in a double staggered row at 100 mm centres. Locate nails no closer than 75 mm from face.

- .4 Install an additional piece of base sheet (minimum 150 mm X 150 mm) centered over joints and corners of drip flashing and carried to within 25 mm of edge. Review procedures with the Consultant before proceeding.
- .5 Install 1-ply of base to 25 mm from drip edge and continuing a minimum of 150 mm beyond flashing flange. Ensure positive bond to all metal as to provide a continuous permanent watertight seal.
- .6 Install cap sheet as specified and trim flush with outside face with hot roofing knife. Work underlying surfaces with broom, roller or wet sponge as required to obtain a positive continuous permanent watertight seal.

### **3.20 ROOF DRAINS**

- .1 Install self-adhered membrane air seal around drain and extend onto air/vapour barrier minimum 150 mm.
- .2 Unless otherwise specified or shown, provide prefabricated sump of sloped polyisocyanurate insulation 1200 mm each side of the centre of the drain. Reduce polyisocyanurate insulation thickness to minimum 19 mm at drain to provide positive roof drainage (make allowance for thickness of all flanges and clamps) and ensure water flow will not be impeded.
- .3 Complete roof membrane, installing additional 1 m x 1 m base sheet flashing centred over drain opening.
- .4 Fully coat drain flange to receive roofing with modified sealant and continue modified bitumen over flange. Neatly trim and work membrane to interior face and seal with Type 'A' sealant.
- .5 Set clamping ring in solid bed of Type 'A' sealant. Secure clamp ring and integral screen as dictated by drain design immediately after membrane is installed. Tighten bolts to ensure a permanent watertight compression seal.
- .6 Install and bolt strainers with heavy iron mechanical bracket to ensure the drain screen remains permanently in place to the Consultant's approval.
- .7 Install test plug, water test roof and repair leaks. Remove test plug once complete.
- .8 Restore interior finishes affected by work of this Contract to match original materials and finishes to Consultant's approval. Insulate rainwater leader pipes as required by Summary of Work in accordance with Section 22 05 11 – Plumbing and Drainage.

### **3.21 PLUMBING VENTS, B-VENTS, STACKS AND SLEEVES**

- .1 Inspect and clean soil pipes of debris to ensure they are operational.
- .2 Protect exposed surface during roofing operation and clean surfaces free of bitumen before leaving site.



- .3 Make all penetrations air and watertight at air/vapour barrier by installing self-adhesive membrane flashings 150 mm onto air/vapour barrier and carry up and around projection. Clamp in place and caulk.
- .4 Trim base sheet at roof projections.
- .5 Adjust existing pipes to new flashing heights by either cutting down or extending pipes with matching materials attached with mechanical couplers. Ensure pipes are 38 mm higher than flashing to allow for sealing to prevent condensation.
- .6 Clear all projections free of contaminants and seal junction of base sheet and roof projections with trowel applications of sealant as shown on drawings.
- .7 Install all metal flanges to be built into the membrane before the installation of cap sheet. Insulate sleeves in accordance with drawings as specified. Where required, install telescoping caps to detail.
- .8 Prime topside and underside of all flanges to be incorporated with roofing prior to application. Use primer supplied by the membrane manufacturer. All primer to be dry before installation of membrane roofing or flashing.
- .9 Before installing flashings, install 1-ply base sheet extending to opening. Set flanges in bed of Type 'A' sealant prior to membrane installation, as per manufacturer's recommendations.
- .10 Install 1-ply of base sheet flashings thermofused to the flange to within 25 mm from upturn and continuing a minimum of 225 mm beyond flange. Continue cap sheet to metal upturn. Seal around upturn junction with sealant and touch up with matching granules, as per manufacturer's recommendations.
- .11 Install rain collars over sleeves and stacks as indicated to match adjoining materials and seal with sealant as indicated on drawings.

### **3.22 CONCRETE PAVERS**

- .1 Install concrete pavers at the top and bottom of all roof access ladders accessing roof areas to be replaced in this contract.
- .2 Install concrete pavers at the exit of all roof access doors within the area of work.
- .3 Install concrete pavers at all locations indicated to receive rooftop walkways.
- .4 Set pavers on rubber protection pad, in turn on walkway membrane cap sheet.

### **3.23 LIQUID MEMBRANE FLASHING**

- .1 Using a slow-speed mechanical agitator, thoroughly mix the entire container of resin for two minutes before the addition of catalyst. Pour the resin into a second container if you make a batch mix. Add pre-measured catalyst to the resin component according to the amounts indicated in manufacturer's Catalyst Mixing Chart. Add catalyst only to the amount of material that can be used within 10 to 15 minutes. Stir again for two minutes before applying.

- .2 Apply the first resin layer to the substrate using rollers, brushes or notched squeegees provided for this purpose. The thickness of the first layer must be 1.3 mm to 1.5 mm when wet.
- .3 Lay out the polyester reinforcement on the resin to prevent the formation of wrinkles, swellings or fishmouths.
- .4 Use rollers, brushes or notched squeegees in order to fully saturate resin reinforcement and remove wrinkles and air bubbles under the reinforcement. The appearance of the reinforcement should be slightly opaque without any white trace. It is important to correct these defaults before the resin cures.
- .5 Apply the second resin layer on top of the reinforcement using rollers, brushes or notched squeegees provided for this purpose. The second layer thickness must be 0.6 mm to 0.7 mm when wet.
- .6 Excess resin which is not absorbed should be used to saturate adjacent reinforcement.
- .7 The final resin coating should be smooth and even.
- .8 Each reinforcement shall overlap the previous one by 50 mm laterally and by 100 mm at the ends.

### **3.24 CLEAN UP**

- .1 At all times, keep the premises free from accumulation of waste materials or rubbish. Stock piling of debris on the roof will not be permitted.
- .2 Repair defects in surface and bitumen runs with granules to match existing to leave the roof in an even consistent finish.
- .3 Leave roof clear of debris and bitumen left by spills and machine tracking.
- .4 Leave grounds and building free of debris and bitumen spread by pedestrian traffic where applicable.
- .5 Clean surfaces and penetrations of all contaminants and touch up to the satisfaction of the Owner. Include rooftop equipment, curbs, soil stacks, sleeves, gas lines, vents, drains and ladders.
- .6 Check drains to ensure they are functional and where required remove all debris.
- .7 At the completion of the work remove all rubbish, tools, equipment and surplus materials.
- .8 Be responsible to repair and pay all costs and fees required to rectify damage caused by work of the Contract with materials and finish to match original.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED SECTIONS**

- .1 Section 06 10 53 – Miscellaneous Rough Carpentry.
- .2 Section 07 52 00 – Modified Bituminous Membrane Roofing.
- .3 Section 07 92 00 – Joint Sealants.

**1.2 REFERENCE STANDARDS**

- .1 American Society for Testing and Materials International (ASTM)
  - .1 ASTM A240/A240M-16, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
  - .2 ASTM A653/A653M-15e1, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
  - .3 ASTM B32-08(2014), Standard Specification for Solder Metal.
  - .4 ASTM D523-14, Standard Test Method for Specular Gloss.
- .2 Canadian Standards Association (CSA International)
  - .1 CSA A123.3-05(2015), Asphalt Saturated Organic Roofing Felt.
  - .2 CSA A123.22-08(2013), Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
  - .3 CSA B111-1974(R2003), Wire Nails, Spikes and Staples.
- .3 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-51.32-M77, Sheathing, Membrane, Breather Type.
- .4 Canadian Roofing Contractors Association (CRCA)
  - .1 Roofing Specifications Manual 2012.
- .5 Sheet Metal and Air Conditioning Contractors Association of North America (SMACNA)
  - .1 Architectural Sheet Metal Manual – 2012.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit to the Consultant a list of materials intended for use before they are ordered. Submit samples in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature including product specifications and technical data sheets for sheet metal flashing fasteners

and accessory materials. Include product characteristics, performance criteria, physical size, finish and limitation.

- .2 Submit copies of WHMIS 2015 SDS - Safety Data Sheets in accordance with Section 01 35 29.06 - Health and Safety Requirements and Section 01 35 43 - Environmental Procedures.
- .3 Shop Drawings:
  - .1 Submit shop drawings for all sheet metal fabrications.
  - .2 Indicate sheet thickness, flashing dimensions and fastenings. Include anchorage, expansion joints and other provisions for thermal movement.
  - .3 Submit manufacturer's catalogue cut sheets for manufactured items.
- .4 Samples:
  - .1 Submit duplicate 50 x 50 mm samples of each type of sheet metal material, finishes and colours.

#### **1.4 COORDINATION**

- .1 Coordinate work of this Section with Related Work specified in other Sections to ensure construction schedule is maintained and watertightness and protection of the building and finished work is maintained at all times.

#### **1.5 EXAMINATION**

- .1 Do not commence work until surface to be covered has been inspected.
- .2 Inspect work and advise the Consultant of conditions that would adversely affect the work of this trade.
- .3 Commencement of work is proof that the Contractor has accepted surfaces as satisfactory for intended operations and accepts responsibility for appearances and performance of completed work.
- .4 Repair damaged and inferior work caused by work of this Contract with materials and finish to match original to the Consultant's approval.

#### **1.6 MOCK-UPS**

- .1 Submit shop drawings and provide mock-up in accordance with Section 01 33 00 – Submittal Procedures. Before installing materials, provide a 1200 mm mock-up for each profile before fabrication. Cost of mock-up to be included in the Contractor's base bid.
- .2 Mock-up samples to indicate type, colour, size, method of joints, seam, expansion provisions, stiffeners, cleat fasteners and method of sealing joints. Fit mock-up to each applicable roof profile or edge.
- .3 Review mock-up with drawings to ensure design intent can be achieved. Verify all elevations including those with matching materials and sections. Verify that continuity of air seals can be achieved. Verify attachments, methods for securing and strengths to ensure that work can support the anticipated loads and will

remain in place against all wind, weather and service condition without warping or deforming.

- .4 Make adjustments to the work that results from a review of the mock-up without additional cost.
- .5 Acceptable mock-ups may be left in place as part of the final product.

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

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Safety: Comply with requirements of Workplace Hazardous Materials Information System (WHMIS 2015) regarding use, handling, storage, and disposal of materials.
- .3 Manufacturer's recommendations for handling and storing products are to be considered a minimum requirement.
- .4 Materials shall be delivered to the site, undamaged and in their original packages, with manufacturer's labels visible, attesting to their conformity to specific standards.

## **Part 2 Products**

### **2.1 GENERAL**

- .1 All standards, regulations and specifications listed herein are considered to be the latest available edition.
- .2 Compatibility between materials is essential. Use only materials that are known to be compatible when incorporated in a completed assembly.

### **2.2 PREFINISHED SHEET METAL FLASHING**

- .1 Pre-finished metal flashings: As shown on drawings, fabricate from 0.51 mm (26 ga.) steel to ASTM A653 Grade 230 with G90 zinc coating. Surface with Perspectra Series baked enamel finish. Colour to match existing from manufacturer's standard colour range.

### **2.3 ACCESSORIES**

- .1 Metal cleat: same material as metal flashings, 50 mm wide @ 600 mm c/c.
- .2 Continuous metal starter strip: 0.71 mm (24 ga.) galvanized steel, secured at 400 mm c/c.
- .3 Use galvanized, copper, aluminum or stainless steel nails or screws as most compatible with materials and preservatives being utilized.

- .4 Nails: Annular threaded nails of length to penetrate into bases minimum 25 mm. No. 8 screws to penetrate wood 19 mm at 600 mm c/c.
- .5 Masonry fasteners: Tapcon, Permagrip or Tapgrip or Rawl. Spike sized to penetrate concrete 38 mm minimum as specified or shown.
- .6 Exposed fasteners: Where exposed fasteners are specified or as shown, use #10 screws with metal and neoprene washers pre-finished to match colour of flashing. Alternatively, use screws with colour match nylon caps where shown or approved by the Consultant.
- .7 Screws for starter strips and fascia: #8 @ 400 mm c/c.
- .8 Wedges: Rolled plumber sheet lead.
- .9 Sealant: Refer to Drawings and Section 07 92 00 – Joint Sealants.
- .10 Weather barrier membrane: Dry sheathing to CAN/CGSB-51.32, No. 15 perforated asphalt felt to CSA A123.3.
- .11 Self-adhered membrane: To Section 06 10 53, Miscellaneous Rough Carpentry.
- .12 Touch-up paint: As recommended by prefinished material manufacturer.

## **2.4 FABRICATION**

- .1 Fabricate metal flashings and other sheet metal work in accordance with applicable details, as indicated. Where not indicated, follow applicable CRCA 'FL' series details and SMACNA architectural details.
- .2 Metal shall be formed on a bending brake, shaping trimmed and hard seaming shall be done on bench, as far as practicable, with proper sheet metal working tools. Angles of bends and folds for interlocking metal shall be made with full regard to expansion and contraction to avoid buckling and to avoid damaging metal surfaces.
- .3 Fabricate all possible work in shop in maximum 2400 mm lengths by brake forming, bench cutting, drilling and shaping. Match existing profiles where metal flashing is to be repaired.
- .4 Hem exposed edges on underside 13 mm. Mitre and seal corners with sealant.
- .5 Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.
- .6 Dry joints are to be tight but not dented so as to permit slight adjustments of sheets and yet remain watertight.
- .7 Lock seams at all corners.
- .8 Apply isolation coating to metal surfaces to be embedded in concrete or mortar.

- .9 Supply all accessories required for installation of sheet metal work of this Section. Fabricate accessories of same material to which they will be used.

### **Part 3 Execution**

#### **3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

#### **3.2 SHEET METAL FLASHING INSTALLATION**

- .1 Install sheet metal flashings at copings, walls, expansion joints, roof openings and other components required to protect the membrane flashings as shown on the drawings or otherwise required. Where not indicated, follow applicable CRCA 'FL' series details.
- .2 Install continuous concealed starter strips at all exterior faces. Install cleats between lock joints and as indicated to permanently hold flashing in place. Install hook strip fasteners with 2 fasteners per cleat.
- .3 Sheet metal work shall be installed to cover the entire area it protects and shall be watertight under all service and weather conditions. Install in a uniform manner, true to line, free of dents, warping and distortion.
- .4 Back-paint sheet metal that comes into contact with another kind of metal, masonry or concrete with bituminous paint at the rate of 0.15 L/m<sup>2</sup>.
- .5 Install sheet metal with concealed fasteners at lock joints. Exposed fastening will only be permitted with the approval of the Consultant. When exposed fasteners are shown, space all fasteners evenly in an approved manner. Use lead plugs and screws with neoprene washers where fasteners are exposed, otherwise use concrete drive fasteners where metal flashings are installed over concrete masonry.
- .6 Install weather barrier membrane under sheet metal where indicated.
- .7 Self-Adhered Membrane:
- .1 Install 1-ply of self-adhered membrane to detail under sheet metal on horizontal or vertical surfaces that are not otherwise covered by membrane flashings.
- .2 Ensure all surfaces to be covered with self-adhered membrane are complete and free of moisture and contaminants. At temperatures below 5°C (40°F) heat materials to be covered with hot air gun. Store all materials in heated storage above 5°C (40°F) and remove only as much material as can be used before cooling.
- .3 Prime all surfaces to be covered with self-adhered membrane. Let primer tack dry and complete thumb test to ensure.

- .4 Remove paper backing and install membrane true to line to completely cover the area intended to be protected to points shown on the drawing.
- .5 Roll or work material into place by hand to ensure a positive bond.
- .6 Membrane to be installed without air blisters and wrinkles. Rework, repair or replace all poorly installed membrane. Do not stretch material that would result in pull back and deformity of the membrane at intersections.
- .7 Lap all side laps 75 mm and end laps 150 mm. Secure all membrane on vertical surface at points of termination at 150 mm c/c.
- .8 Turn up membrane 150 mm at edge where horizontal surface meets vertical planes.
- .9 Seal all points of termination at horizontal planes and vertical surfaces with modified sealant. Tool sealant to consistent smooth and even surface.
- .10 It is recommended that all self-adhering membrane be installed by a team of two workmen. Avoid working in windy conditions or weather that would result in inferior product.
- .8 Join sheet metal by "S" lock seams, to permit thermal movement. Seal all fasteners and completely fill all joints with Type 'B' sealant as flashing is being installed. Clean off all excessive visible material subsequent to installation.
- .9 When flashing is being installed in more than one piece, offset joints in adjacent flashings by approximately 50%.
- .10 Form inside and outside corners by means of locked seams. Do not use pop rivets unless accepted by Consultant.
- .11 Slope all metal to interior of roof area to maintain slope, unless otherwise indicated. Do not form open joints or pockets that fail to drain water.
- .12 Where existing reglets are to be re-used, remove existing sealant and re-cut to conform to the size requirements specified herein.

### **3.3 CLEANING**

- .1 Proceed in accordance with Section 01 74 00 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment. Remove and replace all sheet metal sections that received surface damage or scratches during fabrication, delivery or installation.
- .3 For scratches and scuffs to be retained in the new installation, use touch up paint recommended by the metal material supplier.
- .4 Leave work areas clean, free from grease, finger marks and stains.

**END OF SECTION**



## Part 1 General

### 1.1 REFERENCE STANDARDS

- .1 ASTM International (ASTM):
  - .1 ASTM A1008/A1008M- 13 Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable
  - .2 ASTM C719- 14, Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle)
  - .3 ASTM C920- 14, Standard Specification for Elastomeric Joint Sealants
  - .4 ASTM E84- 21, Standard Test Method for Surface Burning Characteristics of Building Materials
  - .5 ASTM E136- 19A, Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 degrees
  - .6 ASTM E814- 13a, Standard Test Method for Fire Tests of Penetration Firestop Systems
- .2 Firestop Contractors International Association (FCIA):
  - .1 FCIA Firestop Manual of Practice, 6th Edition 2015
- .3 Factory Mutual Approvals (FM):
  - .1 FM 4990- 2009, Approval Standard for Fire stopping
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Safety Data Sheets (SDS).
- .5 National Research Council Canada (NRC):
  - .1 National Building Code of Canada (NBC) 2015
- .6 ULC Standards (ULC):
  - .1 CAN/ULC-S101- 14, Standard Method of Fire Endurance Tests of Building Construction and Materials
  - .2 CAN/ULC-S102- 10, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
  - .3 CAN/ULC-S115- 11, Standard Method of Fire Tests of Firestop Systems

### 1.2 DEFINITIONS

- .1 Fire Stop Material: device intended to close off opening or penetration during fire or materials that fill openings in wall or floor assembly where penetration is by cables, cable trays, conduits, ducts and pipes and poke-through termination devices, including electrical outlet boxes along with their means of support through wall or floor openings.
- .2 Single Component Fire Stop System: fire stop material that has Listed Systems Design and is used individually without use of high temperature insulation or other materials to create fire stop system.
- .3 Multiple Component Fire Stop System: exact group of fire stop materials that are identified within Listed Systems Design to create on site fire stop system.
- .4 Tightly Fitted; (ref: NBC Part 3.1.9.1(1) and 9.10.9.6(1)): penetrating items that are cast in place in buildings of noncombustible construction or have "0" annular space in buildings of combustible construction.
  - .1 Words "tightly fitted" should ensure that integrity of fire separation is such that it prevents passage of smoke and hot gases to unexposed side of fire separation.
- .5 Fire Blocking: materials, components or system installed in a concealed space in the building to restrict the spread of fire and smoke in that concealed space or from that concealed space to an adjacent space.

- .6 Fire Compartment: spaces within a building that are enclosed by exterior walls or separated from other parts of the building by enclosing Fire Separations having a Fire-Resistance Rating.
- .7 Fire-Resistance Rating: time in minutes or hours that a material or assembly of materials will withstand the passage of flame and transmission of heat when exposed to fire, meeting the requirements of CAN/ULC-S101 or as determined by formal testing of material or assembly of materials, meeting requirements of CAN/ULC-S115, or an interpretation of information derived from formal testing in accordance with requirements of the Building Code and acceptable to the Authority Having Jurisdiction (AHJ).
- .8 Fire Separation: assembly that acts as a barrier against the spread of fire, smoke and noxious gases resulting from combustion as defined by the Building Code and includes the following assemblies having a Fire-Resistance Rating requiring Fire Stopping as follows:
  - .1 Penetration-Type Fire Stop systems located within loadbearing walls and partitions.
  - .2 Penetration-Type Fire Stop systems located within non-loadbearing walls and partitions.
  - .3 Penetration-Type located within floor assemblies.
  - .4 Construction Joint-Type and other assemblies having a Fire-Resistance Rating indicated on Drawings or Schedules.
- .9 Fire Stop: material, component or system, and its means of support, used to protect gaps between fire separations, between fire separations and other construction assemblies, or used in openings where penetrating items wholly or partially penetrate fire separations, to restrict the spread of fire and smoke thus maintaining the fire-resistance continuity of a fire separation.
- .10 Fire Stop System: a specific site erected construction consisting of the assembly, fire stop materials, any penetrating items and their means of support which have met the requirements for an F, FT, FH, FTH and/or L rating when tested in a fire-resistance rated assembly in accordance with CAN/ULC-S115.
  - .1 F-Rating: the amount of time a fire stop system can remain in place without the passage of flame through the opening or the occurrence of flaming on the unexposed face of the fire stop.
  - .2 FT-Rating: a fire stop system with an F-Rating for the required time period which can also resist the transmission of heat through the fire stop during the same period and limit the rise in temperature on the unexposed face and/or penetrating item of the fire stop.
  - .3 FH-Rating: a fire stop system with an F-Rating for the required time period which can also resist the force of a hose stream without developing openings for a prescribed period.
  - .4 FTH-Rating: a fire stop system with an FT-Rating for the required time period which also passes the hose stream test for a prescribed period.
  - .5 L-Rating: largest test sample leakage rate, determined in accordance with the optional air leakage test in CAN/ULC-S115.
- .11 Multi-penetration: two or more service penetrations through an opening in the fire separation.
- .12 Non-rated Fire Separation: fire separation acting as a barrier to the spread of smoke until a response is initiated such as the activation of a fire suppression system.
- .13 Single-penetration: single service penetration through an opening in the fire separation.
- .14 System Design Listing: document providing proof of testing with technical details, specifications and requirements that leads to the application of a specific listed fire stop system.

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
    - .1 Submit electronic copy of WHMIS SDS - Safety Data Sheets.
  - .2 Submit manufacturer's product data for each type of fire stopping and smoke seal. Submit complete product data for each individual component and include:
    - .1 Product name and product number
    - .2 Product characteristics and performance criteria
    - .3 Physical size, finish and limitations
    - .4 Technical data on out-gassing, off-gassing and age testing
    - .5 Curing time
    - .6 Chemical compatibility to other construction materials
    - .7 Shelf life
    - .8 Life expectancy
    - .9 Temperature range for installation
    - .10 Humidity range for installation
    - .11 Sound attenuation STC-Rating
  - .3 Manufacture Product Certification:
    - .1 Submit test reports showing compliance to ASTM E595.
  - .4 Submit a comprehensive list of all products and components included in submittal.
- .3 Shop Drawings:
  - .1 Submit shop drawings showing system design listings for Project including proposed materials, reinforcement, anchorage, fastenings and method of installation.
  - .2 Construction details to accurately reflect actual job conditions for each product and assembly.
  - .3 Submit details for materials and prefabricated devices.
  - .4 Submit electronic copy of shop drawings and include:
    - .1 Title page, labelled "Fire and Smoke Stop System Listings". Include project name, date and the names of the installation company and the manufacturer of proposed products. Electronic copy.
    - .2 Table of Contents in electronic copy.
    - .3 List of each proposed listed fire stop system and corresponding service penetration type or joint type in a matrix spreadsheet schedule, indicating floor and wall system, including rating for each.
    - .4 System Design Listings:
      - .1 Submit design listings for each listed fire stop system and each application identified in accordance with CAN/ULC-S115
      - .2 When more than one product is specified for the listed fire stop system or more than one packing/damming material is indicated, identify the item that will be used on this Project.
    - .5 Certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Quality Assurance Submittals: Submit the following in accordance with Section 01 43 00 - Quality Assurance:
  - .1 Test reports in accordance with CAN/ULC-S101, CAN/ULC-S102, and CAN/ULC-S115.
    - .1 Submit certified test reports from approved independent testing laboratories, indicating compliance of applied fire stopping with specifications for specified performance characteristics and physical properties.
  - .2 Certificates: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

- .3 Manufacturer's Instructions: Submit manufacturer's installation instructions and special handling criteria, installation sequence, and cleaning procedures.
- .4 Manufacturer's Site Reports: Submit manufacturer's reports within three days of review, verifying compliance of Work, as described in SITE QUALITY CONTROL in Part 3 of this Section.
- .5 Engineering Judgments(EJ):
  - .1 Where there is no specific tested listed fire stop system available from the manufacturer for a particular fire stop configuration, review systems from other manufacturers to obtain a listed fire stop system.
  - .2 Submit an EJ from the system manufacturer if there are no listed systems available from other manufacturers.
  - .3 Prepare and submit an EJ in accordance with best practices established in the following documents:
    - .1 IFC Guidelines for Evaluating Engineering Judgments.
    - .2 IFC Guidelines for Evaluating Engineering Judgments - Perimeter Fire Barrier Systems.
  - .4 For each EJ submitted, include:
    - .1 Project name, number and location.
    - .2 A description of the proposed system with detailed drawing.
    - .3 Installation instructions.
    - .4 Complete descriptions of critical elements for the fire stop configuration.
    - .5 Copies of all referenced system design listings which EJ is based on.
    - .6 EJ issuer name and contact information.
    - .7 Date of issue of EJ with authorization signature of issuer.
  - .5 EJ shall only be issued by fire stop manufacturer's qualified technical personnel or in collaboration with the manufacturer by a knowledgeable registered Professional Engineer, a Fire Protection Engineer or an independent testing agency that provides testing and listing services for fire stop systems similar to the EJ being contemplated.
  - .6 EJ shall be based upon interpolations of previously tested fire stop systems that are either sufficiently similar in nature or clearly bracket the conditions upon which the EJ is to be given. Additional knowledge and technical interpretations based upon accepted engineering principles, fire science and fire testing guidelines (e.g., ASTM E2032 ) may also be used as further support data.
  - .7 EJ shall be based upon knowledge of the elements of the construction to be protected and understanding of the probable behaviour of that construction and the recommended fire stop system protecting it were they to be subjected to the adequate standard fire test method for the required fire rating duration.
  - .8 EJ shall be limited to the specific conditions and configurations for which it was created and should be based upon reasonable performance expectations for the recommended fire stop system under those conditions.
  - .9 EJ shall be accepted only for a single specific job and location and should not be transferred to any other job or location without thorough and appropriate review of all aspects of the next job or location's circumstances.
    - .1 Manufacturer letter stating their opinion, with supporting justification, that the EJ will perform as a fire stop system when subjected to the appropriate standard fire test method for the required fire rating duration.
  - .10 Once the EJ has been reviewed, submit to the AHJ for final approval.
- .6 Closeout Submittals:
  - .1 Operation and Maintenance Data: Submit maintenance data for incorporation into manual, including:
    - .1 product data and manufacturer's installation and maintenance instructions for each product/system used on this project,
    - .2 Certifications:
      - .1 Accreditation of third-party inspection firm.

- .3 Warranty information on fire stop installations.
- .4 Life expectancy of each product installed as part of Project. For each system, list the installation date of products and the expected expiration date (month/year).

#### 1.4 QUALITY ASSURANCE

- .1 Regulatory Requirements: Use materials and methods of determining required thickness of application that have the full acceptance of AHJ and that are tested in accordance with CAN/ULC-S115, and form a part of a ULC or cUL listed system, Engineered Judgement or Equivalent Fire Resistance Rated Assembly.
- .2 Provide systems selection and analysis, installation and inspection of fire stop systems in accordance with the recommended practices detailed in the following guides:
  - .1 FCIA Firestop Manual of Practice (MOP).
- .3 Qualifications:
  - .1 Installer: company person specializing in selection and installation of fire stops with 5 years documented experience approved by manufacturer.
  - .2 Third-Party Inspection Firm: Accredited inspection agency with inspectors who have passed the ULC Firestop Exam or FM Firestop Exam.
- .4 Pre-Installation Meetings: convene pre-installation meeting one week prior to beginning work of this Section, with contractor's representative.
  - .1 Verify project requirements.
  - .2 Review installation and substrate conditions.
  - .3 Co-ordination with other building subtrades.
  - .4 Review manufacturer's installation instructions and warranty requirements.
- .5 Site Meetings: as part of Manufacturer's Services described in PART 3 - FIELD QUALITY CONTROL, schedule site visits, to review Work, at stages listed.
  - .1 After delivery and storage of products, and when preparatory Work is complete, but before installation begins.
  - .2 Twice during progress of Work at 25% and 60% complete.
  - .3 Upon completion of Work, after cleaning is carried out.
- .6 Code - required special inspection - Fire Stopping review and testing by 3rd party inspection agency in accordance with 01 45 00 Quality Control.
- .7 Mock-ups:
  - .1 Construct mock-up of fire stop systems in accordance with Section 01 43 00 - Quality Assurance
  - .2 Before beginning construction, provide mock-up of each proposed listed fire stop system for review by Consultant. Mock-up shall include work by other trades to demonstrate the required finish work, such as steel stud/gypsum board trade framing out multi-penetration openings.
  - .3 After mock-up completion and adequate curing time for materials, provide a minimum of 48 hours notification to Consultant to conduct review.
  - .4 Fire stopping installers and inspection firm shall be present during review of mock-ups.
  - .5 Correct mock-up deficiencies as directed by Consultant. Mock-up may remain as part of finished work.
  - .6 Inspection firm may perform destructive tests to each mock-up to ensure the system meets or exceeds the approved system design listing.

#### 1.5 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
  - .2 Deliver materials to the site in undamaged condition and in original unopened containers, marked to indicate brand name, manufacturer, ULC markings.

- .2 Storage and Protection:
  - .1 Store materials in a well-ventilated, dry indoor location and in accordance with manufacturer's instructions.
  - .2 Replace defective or damaged materials with new.

## 1.6 AMBIENT CONDITIONS

- .1 Ambient Conditions:
  - .1 Install fire stops and smoke seals when ambient and substrate temperatures are within the limits prescribed by the manufacturer and when the substrate is dry and without risk of condensation.
  - .2 Maintain manufacturer's recommended ambient and substrate temperatures for 48 hours before and 72 hours after installation.
- .2 Ventilate fire stops and smoke seals in accordance with manufacturers' instructions by natural means or, where this is inadequate or not available, use forced air circulation.

## 1.7 WARRANTY

- .1 Extend 12 month warranty period to 24 months for Work of this Section.
- .2 Manufacturers shall warrant work of this Section against defects and deficiencies in the product material for a period of 24 months. Promptly correct any defects or deficiencies which become apparent within warranty period at no expense.
- .3 Contractor warrants workmanship on materials and installation for a period of 24 months. Promptly correct any defects or deficiencies which become apparent within warranty period at no expense.

## Part 2 Products

### 2.1 MATERIALS

- .1 Fire stopping and smoke seal systems: in accordance with CAN-ULC-S115.
  - .1 Asbestos-free materials and systems capable of maintaining effective barrier against flame, smoke and gases in compliance with requirements of CAN-ULC-S115 and not to exceed opening sizes for which they are intended and conforming to specified special requirements described in PART 3.
- .2 Use Fire Stop materials from a single manufacturer only for this project. Acceptable Manufacturers:
  - .1 STI Firestop (Specified Firestop Technologies Inc.)
  - .2 Hilti Canada Corporation.
  - .3 3M Canada Inc.
  - .4 Tremco Ltd.
- .3 Service penetration assemblies: systems tested to CAN-ULC-S115.
- .4 Service penetration fire stop components: certified by test laboratory to CAN-ULC-S115.
- .5 Fire-resistance rating of installed fire stopping assembly in accordance with NBC.
- .6 Fire stopping and smoke seals at openings intended for ease of re-entry such as cables: elastomeric seal.
- .7 Pillow type fire stopping and smoke seals at openings intended for ease of re-entry such as cables and cable traps.
- .8 Fire stopping and smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: elastomeric seal.
- .9 Primers: to manufacturer's recommendation for specific material, substrate, and end use.
- .10 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
- .11 Damming and backup materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.

- .12 Sealants for vertical joints: non-sagging.
- .13 Fire caulking installed in areas with exposed or painted structure to be white paintable type.

## 2.2 PERFORMANCE/DESIGN CRITERIA

- .1 Fire stop and smoke seal systems consisting of a material or combination of materials installed to maintain the integrity of the fire-resistance rating of a fire separation in accordance with the requirements of the NBC.
- .2 Performance Requirements: Manufacturer shall design proprietary assemblies to withstand the listed ratings in accordance with the NBC, ULC Standards, and AHJ, and as follows:
  - .1 Non-rated fire separations: Provide L-Rated smoke protection fire stop system for application on both sides of separation.
  - .2 Provide through-penetration fire stop and joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of penetrated assembly, such as:
    - .1 Fire-resistance rated loadbearing walls, including partitions, with fire protection rated openings.
    - .2 Fire-resistance rated non-loadbearing walls, including partitions with fire protection rated openings.
    - .3 Fire-resistance rated floor assemblies.
  - .3 "F" Rated Systems: Provide through-penetration fire stop systems with F-ratings indicated, as determined by CAN/ULC-S115 or ASTM E814, and equal to or exceeding the fire-resistance rating of the penetrations created during construction.
  - .4 "T" Rated Systems: Where fire stop systems protect penetrating items from potential contact with adjacent materials, provide through-penetration fire stop systems with T-ratings and F-ratings indicated, as determined by CAN/ULC-S115 or ASTM E814, for the following conditions:
    - .1 Penetrations located outside wall cavities.
    - .2 Penetrations located outside fire resistive shaft enclosures.
    - .3 Penetrations located in a construction containing fire protection rated openings.
    - .4 Penetrating items larger than a 100-mm-diameter nominal pipe or 100 cm<sup>2</sup> in overall cross-sectional area.
  - .5 Fire stopping and Smoke Seal Systems Exposed to View: Provide products that after curing do not deteriorate when exposed to view, traffic, moisture, and physical damage both during and after construction, and as follows:
    - .1 Provide moisture resistant through-penetration fire stop systems for piping penetrations for plumbing and wet pipe sprinkler systems.
    - .2 Provide fire stopping and smoke seal systems capable of supporting anticipated floor loads either by installing floor plates or by other means for floor penetrations with annular spaces exceeding 100 mm in width and exposed to possible loading and traffic.
    - .3 Provide fire stopping and smoke seal systems not requiring removal of insulation for penetrations involving insulated piping.
    - .4 Provide products with flame-spread ratings of less than 25 and smoke-developed ratings of less than 50 for fire stopping, smoke seal, and joint systems exposed to view.
    - .5 Architectural considerations: When fire stop system is exposed to view, consider architectural finish, potential traffic, and exposure to moisture and heat.

- .6 Fire Resistance of Joint Systems: Assembly ratings and movement capabilities shall be as indicated with assembly ratings equal to or exceeding the fire-resistance rating of constructions in which joints are located.
- .3 Acoustic insulation properties as indicated in wall schedule.
- .4 Dynamic Joints: Where required, design fire stop and smoke seal systems to accommodate a defined amount of movement in structural elements, construction joints and mechanical piping caused by expansion or contraction. Systems should also accommodate movement and sound and vibration control in mechanical installations.
- .5 Insulated Pipes and Ducts: Design and test listed fire stop system with the actual insulation materials penetrating the fire separation, as indicated on the system design listing.
- .6 Use in Wet Areas: water-based products are unacceptable in wet areas or areas that may be subject to occasional water exposure or flooding during and after construction.

## 2.3 MATERIALS

- .1 Compatibility: Under conditions of service and application, provide fire stopping and smoke seal systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating the systems, as demonstrated by fire stopping and smoke seal system manufacturer based on testing and site experience, and as follows:
  - .1 Asbestos-free materials and systems capable of maintaining an effective barrier against the passage of flame, smoke and water and the transmission of heat in compliance with requirements of CAN-ULC-S115 and not to exceed opening sizes for which they are intended, as indicated on System Design Listing.
  - .2 Fire Stop System Rating: To match fire-resistance rating of fire separation as indicated on Drawings.
  - .3 Service penetration assemblies and fire stop components: Certified by testing laboratory to CAN/ULC-S115.
  - .4 Provide elastomeric seal or non-shrink foam cement mortar for fire and smoke stop systems at openings intended for re-entry, such as cables. Do not use cementitious or rigid seal at such locations.
  - .5 Provide elastomeric protection for fire and smoke stop systems at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control. Do not use a cementitious or rigid seal at such locations. Exemption for fire dampers.
  - .6 Provide elastomeric seal for fire and smoke seals behind and around mechanical and electrical boxes within wall, floor, and ceiling assemblies.

## 2.4 FILL MATERIALS

- .1 General:
  - .1 Provide fire stopping and smoke seal systems containing the types of fill materials indicated in SCHEDULE in Part 3 of this Section by reference to the types of materials described in this Article. Fill materials are those referred to in directories of the referenced testing and inspecting agencies as fill, void, or cavity materials.
  - .2 Fire stopping and smoke seal systems shall be tested in accordance with CAN/ULC-S115 and be comprised of asbestos free materials and systems capable of maintaining an effective barrier against flame, smoke and gases. Fire stopping and smoke seal systems not to exceed opening sizes for which they are intended for the ratings as indicated on Drawings.
- .2 Latex Sealants: Single component latex formulations that after curing do not re-emulsify during exposure to moisture.



- .3 Fire Stopping and Smoke Seal Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrating item.
- .4 Cable Penetration Devices:
  - .1 Pre-manufactured intumescent blocks
  - .2 Pre-manufactured sleeves, consisting of an adjustable core
  - .3 Pre-manufactured cable management system, consisting of a system of intumescent inserts and adjustable cores
- .5 Intumescent Composite Sheets: Rigid panels consisting of aluminum foil faced elastomeric sheet bonded to galvanized steel sheet.
- .6 Intumescent Putties: Non-hardening dielectric, water resistant putties containing no solvents, inorganic fibres, or silicone compounds.
- .7 Intumescent Spray Foam: Expanding spray-in-place intumescent foam sealant.
- .8 Intumescent Wrap Strips: Single component intumescent elastomeric sheets with aluminum foil on one side.
- .9 Intumescent, Latex Sealant: Single-component, intumescent, latex formulation.
- .10 Job-Mixed Vinyl Compound: Prepackaged vinyl-based powder product for mixing with water at Project site to produce a paintable compound, passing ASTM E136, with flame-spread and smoke-developed ratings of zero per ASTM E84.
- .11 Solvent-Release-Curing Intumescent Sealant: Solvent-release-curing, single-component, synthetic-polymer-based sealant of grade indicated below:
  - .1 Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces. Non-sag formulation for openings in vertical and other surfaces requiring a non-slumping/gunnable sealant, unless indicated fire stop system limits use non-sag grade.
- .12 Mortars: Pre-packaged, dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a non-shrinking, homogeneous mortar.
- .13 Pillows/Bags: Reusable, heat-expanding pillows/bags consisting of glass fibre cloth cases filled with a combination of mineral fibre, water insoluble expansion agents and fire-retardant additives.
- .14 Silicone Foams: Multi-component, silicone based liquid elastomers that, when mixed, expand and cure in-place to produce a flexible, non-shrinking foam.
- .15 Silicone Sealants: Moisture curing, single component, silicone based, neutral curing elastomeric sealants of grade indicated below:
  - .1 Grade for Horizontal Surfaces: Pourable (self-levelling) formulation for openings in floors and other horizontal surfaces.
  - .2 Grade for Vertical Surfaces: Non-sag formulation for openings in vertical and other surfaces.
- .16 Ceramic-Fibre and Mastic Coating: Ceramic fibres in bulk form formulated for use with mastic coating, and ceramic fibre manufacturer's mastic coating.
- .17 Ceramic-Fibre Sealant: Single-component formulation of ceramic fibres and inorganic binders.

## 2.5 MIXING

- .1 For those products requiring mixing before application, comply with fire stopping and smoke seal system manufacturer's instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

## 2.6 FIRE-RESISTIVE ELASTOMERIC JOINT SEALANTS

- .1 Elastomeric Sealant Standard: Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer that comply with ASTM C920 requirements,

- including those referenced for Type, Grade, Class, and Uses, and requirements specified in this Section applicable to fire-resistive joint sealants.
- .2 Single-Component, Neutral-Curing Silicone Sealant: Type S; Grade NS; Class 25; exposure-related Use NT, and joint-substrate-related Uses M, G, A, and (as applicable to joint substrates indicated) O.
    - .1 Additional Movement Capability: When tested for adhesion and cohesion under maximum cyclic movement per ASTM C719, provide sealant with the capability to withstand the changes in joint width existing at the time of installation, and remain in compliance with other requirements of ASTM C920.
  - .3 Multicomponent, Non-sag, Urethane Sealant: Type M; Grade NS; Class 25; exposure-related Use NT, and joint-substrate-related Uses M, A, and (as applicable to joint substrates indicated) O.
    - .1 Additional Movement Capability: When tested for adhesion and cohesion under maximum cyclic movement per ASTM C719, provide sealant with the capability to withstand the change in joint width existing at the time of installation, and remain in compliance with other requirements of ASTM C920.
  - .4 Single-Component, Non-sag, Urethane Sealant: Type S; Grade NS; Class 25; and Uses NT, M, A, and (as applicable to joint substrates indicated) O.

## 2.7 ACCESSORIES

- .1 Provide components for each fire stopping and smoke seal system needed to install fill materials. Use only components specified by fire stopping and smoke seal system manufacturer and approved by the qualified testing and inspecting agency for fire stopping and smoke seal systems indicated on Drawings.
- .2 Primers: To manufacturer's recommendation for specific material, substrate, and end use.
- .3 Water (if applicable): Potable, clean and free from harmful amounts of deleterious substances.
- .4 Metal Fire Stop: Commercial galvanized steel, to ASTM A1008/A1008M, zinc coating 260 g/m<sup>2</sup>, minimum metal core thickness 0.912 mm.
- .5 Steel Deck Moulded Flute Inserts: One-piece moulded mineral fibre flute inserts, sized for steel deck profiles, for placement at top of fire-rated wall assemblies
- .6 Packing/Damming Materials, Supports and Anchoring Devices: To manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to AHJ.
- .7 Fire Stop Insulation: Pre-formed, semi-rigid, non-combustible mineral wool, pre-cut in 1220-mm lengths to required depth and width.
- .8 Junction Box/Outlet Sealing Putty: Intumescent putty, pre-formed in pads.
- .9 Sealants: Good adhesion without use of primer, high visibility safety colours.
  - .1 Flame-spread rating: Maximum 25
  - .2 Smoke development classification: Maximum 50
  - .3 For vertical joints: Non-sagging
  - .4 For horizontal joints: Single component, self-levelling

## Part 3 Execution

### 3.1 EXAMINATION

- .1 Verify that conditions of substrates previously installed are acceptable for product installation in accordance with manufacturer's instructions and approved system design listings for each condition.
- .2 Verify each opening/annular space to ensure it does not exceed the maximum and minimum dimensions indicated on the approved system design listing.

- .3 Verify that all joints, service penetrating elements and supporting devices/hangers have been properly installed as indicated on approved system design listings. Remove all temporary lines and markings to meet the approved system design listings.
- .4 Verify that proposed fire stop system consists of components that are compatible with each other, with substrates forming the openings, and with items, if any, penetrating the fire stop under conditions of application and service, as demonstrated by the fire stop manufacturer based on testing and site experience.
- .5 Pipe and Duct Insulation: Confirm that proposed fire stop system has been tested with the actual insulation penetrating the fire separation on site, as indicated in the approved system design listing. Maintain insulation around pipes and ducts penetrating the fire separation.
- .6 Ensure no additional items have been installed through opening that does not appear on the approved system design listing.
- .7 Ensure fire stopped areas are accessible for proper application and that conditions are suitable for installation of the fire stop system. Areas to remain accessible for inspection.
- .8 Report in writing to Consultant any defective surfaces or conditions affecting the fire stop system installation immediately and before commencing any installations.
- .9 Proceed only once defected surfaces or conditions have been corrected.
- .10 Proceed with installation only after unacceptable conditions have been remedied.

### **3.2 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

### **3.3 PREPARATION**

- .1 Examine sizes and conditions of voids to be filled to establish correct thicknesses and installation of materials.
  - .1 Ensure that substrates and surfaces are clean, dry and frost free.
- .2 Prepare surfaces in contact with fire stop and smoke stop materials to manufacturer's instructions.
- .3 Maintain insulation around pipes and ducts penetrating fire separation without interruption to vapour barrier.
- .4 Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.
- .5 Prime surfaces as required.
- .6 Ensure multi-penetration openings have been framed and boarded out around annular openings, as indicated in the system design listing before prepping the opening.

### **3.4 INSTALLATION**

- .1 Install fire stop and smoke seal materials and components in accordance with manufacturer's certified tested system listing and ULC certification.
- .2 Seal holes or voids made by through-penetrations, poke-through termination devices, and un-penetrated openings or joints to ensure that both continuity and integrity of fire separation are maintained.
- .3 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing per manufacturer's instructions.
- .4 Tool or trowel exposed surfaces to neat finish.
- .5 Remove excess compound promptly as work progresses and upon completion.
- .6 Protect gaps around recessed components (e.g., panels, electrical boxes, outlets) with sealing putty in accordance with manufacturer's instructions.
- .7 Do not use damaged or expired material.

### **3.5 INSTALLATION - JOINT FIRE STOPS**

- .1 For sealant applications, install joint fillers to support fire stop materials during application. Position joint fillers to ensure fire stop material cross-sectional shape and thickness relative to the joint width allows for optimum sealant movement, while developing the required fire-resistance rating.
- .2 Install fire stops using techniques recommended by the manufacturer:
  - .1 Fully wetting joint substrates to optimize adhesion.
  - .2 Completely filling recesses provided for each joint configuration.
  - .3 Tool non-sag fire stop materials immediately after their application and before the time skinning begins. Form smooth, uniform beads of configuration indicated or required to
    - .1 provide required fire-resistance rating,
    - .2 eliminate air pockets, and
    - .3 ensure contact and adhesion with sides of joint.
  - .4 Joint Systems and Perimeter Fire Containment Systems:
    - .1 For systems with dynamic joints, ensure movement capabilities of the installation meet or exceed the movement expectations of the system design listing and manufacturer's installation instructions.

### **3.6 INSTALLATION - THROUGH PENETRATION JOINT SEALANTS**

- .1 Install forming/damming materials and other accessories of types required to support fill materials during their application and in the position required to achieve fire ratings of designated through-penetration fire stop systems.
- .2 Install fill materials for through-penetration fire stop systems by techniques recommended by the manufacturer to produce the following results:
  - .1 Completely fill voids and cavities formed by openings, forming materials, accessories, and penetrating items.
  - .2 Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
  - .3 For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.
- .3 Remove combustible forming materials and other accessories not indicated as permanent components of fire stop systems.

### **3.7 REPAIRS AND MODIFICATIONS**

- .1 Identify damaged or re-entered seals requiring repair or modification.
- .2 Remove loose or damaged materials. If adding penetrating items, remove sufficient material to insert new elements and to avoid damaging the balance of the seal.
- .3 Ensure sealed surfaces are clean and dry.
- .4 Use only materials that are suitable for repair of original seal, as approved by manufacturer. Do not mix products from different manufacturers.

### **3.8 SEQUENCES OF OPERATION**

- .1 Proceed with installation only when submittals have been reviewed by Consultant.
- .2 Install floor fire stopping before interior partition erections.
- .3 Metal deck bonding: fire stopping to precede spray applied fireproofing to ensure required bonding.
- .4 Mechanical pipe insulation: certified fire stop system component.
  - .1 Ensure pipe insulation installation precedes fire stopping.

### **3.9 SITE QUALITY CONTROL**

- .1 Inspections: Notify Consultant when ready for inspection and before concealing or enclosing fire stop materials and service penetration assemblies.
- .2 Manufacturer's Field Services:
  - .1 Obtain report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Site Reports as described in SUBMITTALS in Part 1 of this Section.
  - .2 Provide manufacturer's site services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

### **3.10 CLEANING**

- .1 Perform cleaning on a daily basis while work is ongoing.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- .3 Remove temporary dams after initial set of fire stop and smoke seal materials.

### **3.11 SCHEDULE**

- .1 Fire stop and smoke seal at:
  - .1 Penetrations through fire-resistance rated masonry, concrete, and gypsum board partitions and walls.
  - .2 Edge of floor slabs at curtain wall and precast concrete panels.
  - .3 Top of fire-resistance rated masonry and gypsum board partitions.
  - .4 Intersection of fire-resistance rated masonry and gypsum board partitions.
  - .5 Control and sway joints in fire-resistance rated masonry and gypsum board partitions and walls.
  - .6 Penetrations through fire-resistance rated floor slabs, ceilings and roofs.
  - .7 Openings and sleeves installed for future use through fire separations.
  - .8 Around mechanical and electrical assemblies penetrating fire separations.
  - .9 Rigid ducts: greater than 129 cm<sup>2</sup> : fire stopping to consist of bead of fire stopping material between retaining angle and fire separation and between retaining angle and duct, on each side of fire separation.

**END OF SECTION**



**PART 1 General**

**1.1 REFERENCES**

- .1 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-19.13-M87, Sealing Compound, One-component, Elastomeric, Chemical Curing.
  - .2 CAN/CGSB-37.5-M89, Cutback Asphalt Plastic Cement
- .2 General Services Administration (GSA) - Federal Specifications (FS)
  - .1 FS-SS-S-200-E(2)1993, Sealants, Joint, Two-Component, Jet-Blast-Resistant, Cold Applied, for Portland Cement Concrete Pavement.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for joint sealants and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Manufacturer's product to describe:
    - .1 Caulking compound.
    - .2 Primers.
    - .3 Sealing compound, each type, including compatibility when different sealants are in contact with each other.
  - .3 Submit 2 copies of WHMIS 2015 SDS in accordance with Section 01 35 29.06 - Health and Safety Requirements and Section 01 35 43 - Environmental Procedures.
- .3 Manufacturer's Instructions: Submit instructions to include installation instructions for each product used.

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect joint sealants from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

## **1.4 SITE CONDITIONS**

- .1 Ambient Conditions:
  - .1 Proceed with installation of joint sealants only when:
    - .1 Ambient and substrate temperature conditions are within limits permitted by joint sealant manufacturer or are above 4.4°C.
    - .2 Joint substrates are dry.
    - .3 Conform to manufacturer's recommended temperatures, relative humidity, and substrate moisture content for application and curing of sealants including special conditions governing use.
- .2 Joint-Width Conditions:
  - .1 Proceed with installation of joint sealants only where joint widths are more than those allowed by joint sealant manufacturer for applications indicated.
- .3 Joint-Substrate Conditions:
  - .1 Proceed with installation of joint sealants only after contaminants capable of interfering with adhesion are removed from joint substrates.

## **PART 2 Products**

### **2.1 SEALANT MATERIALS**

- .1 Do not use caulking that emits strong odours, contains toxic chemicals or is not certified as mould resistant in air handling units.
- .2 When low toxicity caulks are not possible, confine usage to areas which off gas to exterior, are contained behind air barriers, or are applied several months before occupancy to maximize off gas time.
- .3 Where sealants are qualified with primers use only these primers.

### **2.2 SEALANT MATERIAL DESIGNATIONS**

- .1 Modified bitumen sealant (Sealant Type 'A'):
  - .1 For penetration and terminations of bituminous and modified bituminous membrane: To CAN/CGSB-37.5. As recommended by membrane manufacturer.
  - .2 Standard of acceptance:
    - .1 Sopramastic 200 by Soprema.
    - .2 Aquabarrier Mastic by IKO.
    - .3 Polybitume 570-05 by Henry.
    - .4 Or accepted alternate.



- .2 Silicones one part (Sealant Type 'B'):
  - .1 To CAN/CGSB-19.13 and ASTM C920, Type S, Grade NS, Class 35, colour to match surfaces.
  - .2 Standard of acceptance:
    - .1 Tremsil 400 by Tremco.
    - .2 Dowsil CWS by Dow.
    - .3 Or accepted alternate.
- .3 High temperature sealant (Sealant Type 'C'):
  - .1 One component, low modulus, gun grade, non-sag, moisture-cure polyurethane sealant with UV resistance, designed to cure into a fire rated, elastic weatherproof seal. Sealant shall comply with AS1530 Part 4-1997 (Fire Resistance Test of Elements of Building Construction) and AS4072 Part 1-1992 (Service penetrations and control joints). Tested by BRANZ.
  - .2 Standard of acceptance:
    - .1 Dow Corning 736 Silicone.
    - .2 Or accepted alternate.

## **2.3 JOINT CLEANER**

- .1 Non-corrosive and non-staining type, compatible with joint forming materials and sealant recommended by sealant manufacturer.

## **2.4 PRIMER**

- .1 As recommended by sealant manufacturer for specific substrate adhesion.

# **PART 3 Execution**

## **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for joint sealants installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Consultant.
  - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied.

## **3.2 SURFACE PREPARATION**

- .1 Examine joint sizes and conditions to establish correct depth to width relationship for installation of backup materials and sealants.
- .2 Clean bonding joint surfaces of harmful matter substances including dust, rust, oil grease, and other matter which may impair Work.

- .3 Do not apply sealants to joint surfaces treated with sealer, curing compound, water repellent, or other coatings unless tests have been performed to ensure compatibility of materials. Remove coatings as required.
- .4 Ensure joint surfaces are dry and frost free.
- .5 Prepare surfaces in accordance with manufacturer's directions.

### **3.3 BACKUP MATERIAL**

- .1 Install joint filler to achieve correct joint depth and shape, with approximately 30% compression.

### **3.4 APPLICATION**

- .1 Sealant:
  - .1 Apply sealant in accordance with manufacturer's written instructions.
  - .2 Mask edges of joint where irregular surface or sensitive joint border exists to provide neat joint.
  - .3 Apply sealant in continuous beads.
  - .4 Apply sealant using gun with proper size nozzle.
  - .5 Use sufficient pressure to fill voids and joints solid.
  - .6 Form surface of sealant with full bead, smooth, free from ridges, wrinkles, sags, air pockets, embedded impurities.
  - .7 Tool exposed surfaces before skinning begins to give slightly concave shape.
  - .8 Remove excess compound promptly as work progresses and upon completion.
- .2 Curing:
  - .1 Cure sealants in accordance with sealant manufacturer's instructions.
  - .2 Do not cover up sealants until proper curing has taken place.
- .3 Install sealant Type 'B' at exterior perimeter or window and door frames.
- .4 Install sealant Type 'C' at all B-vent collars and at all high temperature locations.

### **3.5 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day. Clean adjacent surfaces immediately.
  - .2 Remove excess and droppings, using recommended cleaners as work progresses.
  - .3 Remove masking tape after initial set of sealant.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.

- .3 Waste Management: separate waste materials for recycling.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**3.6 PROTECTION**

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

**END OF SECTION**



## **Part 1 General**

### **1.1 SUMMARY**

- .1 Section includes:
  - .1 Materials and application of acoustical units for direct application or for application and installation within a suspended ceiling.
  - .2 Acoustical Suspension system.

### **1.2 REFERENCE STANDARDS**

- .1 ASTM International (ASTM)
  - .1 ASTM C635/C635M-13a, Standard Specifications for the Manufacture, Performance and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings.
  - .2 ASTM C636/C636M-08, Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
  - .3 ASTM E1264-14, Standard Classification for Acoustical Ceiling Products.
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-92.1-M89, Sound Absorptive Prefabricated Acoustical Units.

### **1.3 COORDINATION**

- .1 Do not begin erection of ceiling suspension system until work above ceiling has been inspected by Consultant.

### **1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Shop Drawings:
  - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

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

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Storage and Handling Requirements:
  - .1 Protect on site stored or installed absorptive material from moisture damage.
- .3 Waste Management and Disposal:
  - .1 Separate waste materials for reuse, recycling or disposal in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .2 Divert unused metal materials from landfill to metal recycling facility.
  - .3 Remove from site and dispose of packaging materials at appropriate recycling facilities.
  - .4 Fold up metal and plastic banding, flatten and place in designated area for recycling.

### **1.6 EXTRA MATERIALS**

- .1 Provide acoustical units amounting to 2% of gross ceiling area for each pattern and type required for project.
- .2 Ensure extra materials are from same production run as installed materials.
- .3 Clearly identify each type of acoustic unit, including colour and texture.
- .4 Deliver to Owner, upon completion of the work of this section.

## **Part 2 Products**

## 2.1 DESIGN CRITERIA

- .1 Design Requirements:
  - .1 Maximum deflection: 1/360th of span to ASTM C635/ASTM C635M deflection test.

## 2.2 ACOUSTICAL CEILING SUSPENSION

- .1 Suspension system to ASTM C 635.
- .2 Basic materials for suspension system: commercial quality cold rolled steel mill finished.
- .3 Suspension system: Heavy duty two directional exposed tee bar grid system:
  - .1 Two directional exposed tee bar 610 mm x 1220mm grid.
  - .2 Acceptable product: Donn DX/DXL by CGC or approved equal.
- .4 Exposed tee bar grid components: shop painted satin sheen white. Components die cut. Main tee with double web, rectangular bulb and 25 mm rolled cap on exposed face. Cross tee with rectangular bulb; web extended to form positive interlock with main tee webs; lower flange extended and offset to provide flush intersection.
- .5 Hanger wire: galvanized soft annealed steel wire:
  - .1 3.6 mm diameter for access tile ceilings.
- .6 Accessories: splices, clips, wire ties, retainers and wall moulding flush and preformed corner cover, to complement suspension system components, as recommended by system manufacturer.

## 2.3 ACOUSTICAL CEILING PANELS

- .1 Acoustic units for suspended ceiling system: to CAN/CGSB-92.1-M89 ASTM E 1264-98.
  - .1 610mm x 1220mm x 16mm (24" x 48" x 5/8"), square edge, white.
    - .1 Acceptable product:
      - .1 Baroque PBT-197 by CertainTeed.

## Part 3 Execution

### 3.1 SUSPENSION SYSTEM INSTALLATION

- .1 Comply with manufacturer's written installation instructions and recommendations, including product technical bulletins, product carton installation instructions, and data sheets.
- .2 Install suspension system in accordance with accepted shop drawings, Certification Organizations tested design requirements and ASTM C636/C636M except where specified otherwise.
- .3 Do not erect ceiling suspension system until work above ceiling has been inspected by Consultant.
- .4 Lay out centre line of ceiling both ways, to provide balanced borders at room perimeter with border units not less than 50% of standard unit width, also refer to reflected ceiling plan.
- .5 Finished ceiling system to be square with adjoining walls and level within 1:1000.
- .6 Secure hangers system to existing structural steel.
- .7 Install hangers spaced at maximum 1200 mm centres and within 150 mm from ends of main tees.
- .8 Ensure suspension system is coordinated with location of related components.
- .9 Install wall moulding to provide correct ceiling height.
- .10 Completed suspension system to support super-imposed loads, such as lighting fixtures, diffusers, grilles and speakers.
- .11 Support at light fixtures and diffusers with additional ceiling suspension hangers within 150 mm of each corner and at maximum 600 mm around perimeter of fixture.
- .12 Interlock cross member to main runner to provide rigid assembly.

- .13 Frame at openings for light fixtures, air diffusers, speakers and at changes in ceiling heights.
- .14 Install perimeter trim.
- .15 Install preformed corner cover to all bullnosed block corners.

### **3.2 ACOUSTICAL CEILING PANEL INSTALLATION**

- .1 Install acoustical panels and tiles in ceiling suspension system in accordance with manufacturer's instructions and as indicated.
- .2 Install acoustical units as indicated on reflected ceiling plan.
- .3 Scribe acoustic units to fit adjacent work. Butt joints tight, terminate edges with moulding.
- .4 Co-ordinate ceiling work to accommodate components of other sections, such as light fixtures, diffusers, speakers, sprinkler heads, to be built into acoustical ceiling components.

### **3.3 CLEANING**

- .1 Touch up scratches, abrasions, voids and other defects in painted surfaces.

**END OF SECTION**





## **Part 1 General**

### **1.1 REFERENCE STANDARDS**

- .1 The Master Painters Institute (MPI)
  - .1 Architectural Painting Specification Manual - current edition.

### **1.2 QUALITY ASSURANCE**

- .1 Qualifications: Contractor: minimum of five years proven satisfactory experience. When requested, provide list of last three comparable jobs including, job name and location, specifying authority, and project manager.
- .2 Conform to latest MPI requirements for interior painting work including preparation and priming.
- .3 Materials (primers, paints, coatings, varnishes, stains, lacquers, fillers, thinners, solvents, etc.) shall be in accordance with MPI Painting Specification Manual "Approved Product" listing and shall be from a single manufacturer for each system used.
- .4 Standard of Acceptance:
  - .1 Walls: No defects visible from a distance of 1000 mm at 90° to surface.
  - .2 Ceilings: No defects visible from floor at 45° to surface when viewed using final lighting source.
  - .3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

### **1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit product data for each product to be used.

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

- .1 Packing, Shipping, Handling and Unloading:
  - .1 Pack, ship, handle and unload materials in accordance with Section 01 61 00 - Common Product Requirements and manufacturer's written instructions.
- .2 Acceptance at site:
  - .1 Manufacturer's name and address.
  - .2 Type of paint or coating.
  - .3 Compliance with applicable standard.
  - .4 Colour number in accordance with established colour schedule.
- .3 Remove damaged, opened and rejected materials from site.
- .4 Storage and Protection:
  - .1 Store materials and supplies away from heat generating devices.
  - .2 Store materials and equipment in well ventilated area with temperature range 7 degrees C to 30 degrees C.
- .5 Store temperature sensitive products above minimum temperature as recommended by manufacturer.
- .6 Keep areas used for storage, cleaning and preparation clean and orderly. After completion of operations, return areas to clean condition.

### **1.5 SITE CONDITIONS**

- .1 Heating, Ventilation and Lighting:

- .1 Provide temporary ventilating and heating equipment where permanent facilities are not available or supplemental ventilating and heating equipment if ventilation and heating from existing system is inadequate to meet minimum requirements.
- .2 Provide minimum lighting level of 323 Lux on surfaces to be painted.
- .2 Temperature, Humidity and Substrate Moisture Content Levels:
  - .1 Perform painting work when maximum moisture content of the substrate is below:
    - .1 Allow new concrete and masonry to cure minimum of 28 days.
    - .2 15 % for wood.
    - .3 12 % for plaster and gypsum board.
  - .3 Surface and Environmental Conditions:
    - .1 Apply paint finish in areas where dust is no longer being generated by related construction operations.
    - .2 Apply paint when previous coat of paint is dry or adequately cured.

## Part 2 Products

### 2.1 MATERIALS

- .1 Acceptable manufacturers: Benjamin Moore, Dulux, Para, PPG and Sherwin Williams.
- .2 Products:
  - .1 Primer: BIN primer by Zinsser.
  - .2 Paint: Waterborne Alkyd.
- .3 Supply paint materials for paint systems from single manufacturer.
- .4 Conform to latest MPI requirements for painting work including preparation and priming
- .5 Materials (primers, paints, coatings, varnishes, stains, lacquers, fillers, thinners, solvents, etc.) in accordance with MPI Architectural Painting Specification Manual "Approved Product" listing and as recommended by manufacturer.
- .6 Provide paint products meeting MPI "Environmentally Friendly" E1, E2 E3 ratings based on VOC (EPA Method 24) content levels.
- .7 Colours:
  - .1 Consultant will provide Colour Schedule after Contract award.
  - .2 Colour schedule will be based upon on selection of a maximum of two new base colours and 2 new accent colours. All other painting and patch painting shall match existing.
- .8 Mixing and tinting:
  - .1 Perform colour tinting operations prior to delivery of paint to site.
  - .2 Re-mix paint in containers prior to and during application to ensure break-up of lumps, complete dispersion of settled pigment, and colour and gloss uniformity.
- .9 Gloss/sheen ratings:
  - .1 Paint gloss is defined as sheen rating of applied paint, in accordance with following values:
    - .1

Gloss Level-Category	Gloss @ 60 degrees	Sheen @ 85 degrees
Gloss Level 1 - Matte Finish	Max. 5	Max. 10
Gloss Level 2 - Velvet	Max.10	10 to 35
Gloss Level 3 - Eggshell	10 to 25	10 to 35
Gloss Level 4 - Satin	20 to 35	min. 35
Gloss Level 5 - Semi-Gloss	35 to 70	
Gloss Level 6 - Gloss	70 to 85	
Gloss Level 7 - High Gloss	More than 85	

- .2 Gloss level ratings of painted surfaces as specified herein and as noted on Finish Schedule.

## Part 3 Execution

### 3.1 GENERAL

- .1 Perform preparation and operations for painting in accordance with MPI Architectural Painting and re-painting Specifications Manual except where specified otherwise.
- .2 Apply paint materials in accordance with paint manufacturer's written application instructions.

### 3.2 EXAMINATION

- .1 Investigate existing substrates for problems related to proper and complete preparation of surfaces to be painted. Report to Consultant damages, defects, unsatisfactory or unfavourable conditions before proceeding with work.
- .2 Inform Consultant if any oil based paint is encountered in any area to receive new paint before proceeding with work. Proceed only after written direction is received outlining preparation methods and paint materials to be used.

### 3.3 PREPARATION

- .1 Protection of in-place conditions:
  - .1 Protect existing building surfaces and adjacent structures from paint spatters, markings and other damage by suitable non-staining covers or masking. If damaged, clean and restore surfaces as directed by Consultant.
  - .2 Protect items that are permanently attached such as Fire Labels on doors and frames.
  - .3 Protect factory finished products and equipment.
- .2 Surface Preparation:
  - .1 Remove electrical cover plates, light fixtures, surface hardware on doors, bath accessories and other surface mounted equipment, fittings and fastenings prior to undertaking painting operations. Identify and store items in secure location and re-installed after painting is completed.
  - .2 Place "WET PAINT" signs in occupied areas as painting operations progress. Signs to approval of Consultant.
  - .3 Clean and prepare surfaces in accordance with MPI - Architectural Painting Specification Manual specific requirements and coating manufacturer's recommendations. Refer to MPI Manual in regard to specific requirements and as follows:
    - .1 Sand existing painted surfaces, remove dust, dirt, and other surface debris by vacuuming, wiping with dry, clean cloths or compressed air.
    - .2 Wash surfaces with a biodegradable detergent and bleach where applicable and clean warm water using a stiff bristle brush to remove dirt, oil and other surface contaminants.
    - .3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.
    - .4 Allow surfaces to drain completely and allow to dry thoroughly.
    - .5 Prepare surfaces for water-based painting, water-based cleaners should be used in place of organic solvents.
    - .6 Use trigger operated spray nozzles for water hoses.
    - .7 Many water-based paints cannot be removed with water once dried. Minimize use of mineral spirits or organic solvents to clean up water-based paints.
  - .4 Lightly sand all existing block and concrete surface prime and two coats or paint.
  - .5 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from a distance up to 1000 mm.

- .6 Clean metal surfaces to be painted by removing rust, loose mill scale, welding slag, dirt, oil, grease and other foreign substances in accordance with MPI requirements
- .7 Touch up of shop primers with primer as specified.

### 3.4 APPLICATION

- .1 Painting of rooms to include but not limited to walls, radiation covers, doors, frames, window and door trim, painted base boards, unfinished shelving and other materials which are secured to walls.
- .2 Use method of application approved by Consultant. Apply paint by brush or roller. Conform to manufacturer's application instructions unless specified otherwise..
- .3 Brush and Roller Application:
  - .1 Apply paint in uniform layer using brush and/or roller type suitable for application.
  - .2 Work paint into cracks, crevices and corners.
  - .3 Paint surfaces and corners not accessible to brush using spray, daubers and/or sheepskins. Paint surfaces and corners not accessible to roller using brush, daubers or sheepskins.
  - .4 Brush and/or roll out runs and sags, and over-lap marks. Rolled surfaces free of roller tracking and heavy stipple.
  - .5 Remove runs, sags and brush marks from finished work and repaint.
- .4 Apply coats of paint in continuous film of uniform thickness.
  - .1 Repaint thin spots or bare areas before next coat of paint is applied.
- .5 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.
- .6 Sand and dust between coats to remove visible defects.
- .7 Finish surfaces both above and below sight lines as specified for surrounding surfaces, including such surfaces as tops of interior cupboards and cabinets and projecting ledges.
- .8 Finish closets and alcoves as specified for adjoining rooms.
- .9 Finish top, bottom, edges and cutouts of doors after fitting as specified for door surfaces.
- .10 Prime all surfaces and apply 2 finish coats.

### 3.5 SITE TOLERANCES

- .1 Walls: no defects visible from a distance of 1000 mm at 90 degrees to surface.
- .2 Ceilings: no defects visible from floor at 45 degrees to surface when viewed using final lighting source.
- .3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

### 3.6 FIELD QUALITY CONTROL

- .1 Field inspection of painting operations to be carried out by independent inspection firm as designated by Consultant.
- .2 Advise Consultant when surfaces and applied coating is ready for inspection. Do not proceed with subsequent coats until previous coat has been approved.
- .3 Cooperate with inspection firm and provide access to areas of work.

**END OF SECTION**

## **Part 1 General**

### **1.1 SCOPE OF WORK**

- .1 Supply and installation of roller shades.

### **1.2 DESIGN REQUIREMENTS**

- .1 Design roller shades to following requirements:
  - .1 Be designed in a manner that allows wear susceptible parts to be replaceable by either the user or the manufacturer.
  - .2 Be accompanied by instructions for replacing or repairing worn parts, including inventory numbers for parts and procedures for ordering replacement parts.
  - .3 Be designed in a manner that permits effective disassembly of components in order to permit recycling of materials for which recycling markets exist.
  - .4 Include stamps on all major plastic components indicating composition code to facilitate recycling efforts.

### **1.3 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate dimensions in relation to window jambs, operator details, head and sill anchorage details, hardware and accessories details.
- .3 Widths indicated on drawings are schematic. Where necessary modify configuration, size and quantity of blinds to suit minimum and maximum widths as per manufacturer's recommendations.

### **1.4 SAMPLES**

- .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit duplicate samples of manufacturer's standard colours for selection by Consultant.

### **1.5 WASTE MANAGEMENT AND DISPOSAL**

- .1 Remove and dispose from site all packaging materials at appropriate recycling facilities.
- .2 Dispose of all packaging material in appropriate on-site bin for recycling in accordance with site waste management program.

## **Part 2 Products**

### **2.1 MANUAL ROLLER SHADES**

- .1 Cassette equipped chain roller shade with sheer weave fabric:
  - .1 Stainless steel chain with heavy duty clutch, tie down, and spring assisted system where recommended by manufacturer.
  - .2 Fabric: Woven PVC/Polyester, Sheerweave with 1% openness factor. Meets NFPA 701 for flame retardance. Colour as selected from manufacturers standard range.
  - .3 Removable Fascia, aluminum fascia colour to match window frames.
  - .4 Hem bar: extruded aluminum, colour to match window frames.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install roller shades where indicated. All window blinds to be inside of frame mount.
- .2 Site measure all openings and ensure fit with minimum gaps around shade.
- .3 Include centre brackets where necessary to prevent deflection of headrail.
- .4 Adjust to provide for smooth operation without binding.
- .5 Use non corrosive metal fasteners for installation, concealed in final assembly.
- .6 Do not secure roller shades to window frames.
- .7 Make all systems fully operational, coordinate installation with electrical.
- .8 Check and test operation of each unit and make adjustments to ensure proper installation.

**END OF SECTION**

- 
- |                                 |    |  |
|---------------------------------|----|--|
| <u>1.1 General</u>              | .1 | These instructions apply to all mechanical trades employed on this project.  |
|                                 |    |  |
| <u>1.2 General Requirements</u> | .1 | Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.  |
|                                 |    |  |
| <u>1.3 Documents Required</u>   | .1 | Maintain at job site, one copy each of the following: <ul style="list-style-type: none"><li>.1 Contract drawings</li><li>.2 Specifications</li><li>.3 Addenda</li><li>.4 Reviewed shop drawings</li><li>.5 Change orders</li><li>.6 Other modifications to contract</li><li>.7 Field test reports</li><li>.8 Copy of approved work schedule</li><li>.9 Manufacturer's installation and application instructions.</li></ul>     |
|                                 |    |  |
| <u>1.4 Work Schedule</u>        | .1 | Prior to first application for payment, provide a schedule showing anticipated progress stages and final completion of work.   |
|                                 | .2 | Work schedule shall be in sufficient detail to allow cross referencing to the progress claim breakdown.  |
|                                 | .3 | Submit and updated schedule monthly with the progress payment claim.   |
|                                 |    |  |
| <u>1.5 Cost Breakdown</u>       | .1 | Before submitting the first progress payment claim, submit detailed breakdown of contract price for review and approval of the Consultant and Owner aggregating to the total contract value. Submit breakdown not less than 14 days prior to making first progress claim, and arrange to have a review meeting with the Consultant. Make revisions to breakdown as agreed with the Consultant prior to submitting first claim. |
|                                 | .2 | The breakdown shall be in sufficient detail to identify the labour, material, and start-up for each system, sub system and equipment on a floor by floor basis and area basis, to easily allow verification of progress of work. The information contained herein shall be   |

consistent with the monthly Contractor Status Report information using the same categories expanded and in greater detail where required to identify the value of work executed, and to meet the criteria outlined herein. The breakdown shall include named sub-trades such as the insulating contractor (for piping and ductwork), air balancing contractor, water balancing contractor and major equipment suppliers (those supplying equipment requiring a delivery timeline of more than 2 weeks after shop drawing review).

- .3 Each line item shall include for the contractors over head and profit such that the aggregate amount totals to the contract value without applying multipliers.
- .4 Multiple pieces of equipment that are supplied from one source, shall be broken down into logical categories consistent with the construction and required delivery schedule to meet this criteria.
- .5 The breakdown shall identify separately the testing, adjusting and balancing work, the stipulated commissioning amount, and all cash allowances contained in the contract documents.
- .6 The Consultant reserves the right to request copies of the quotations from suppliers or sub-contractors to verify the cost of materials or services shown in the detailed breakdown where in his opinion there is any doubt as to the adequacy of the amount shown.
- .7 Notwithstanding the above, the Consultant may, in his sole discretion, authorize payment against a progress draw prior to final approval of the cost breakdown where in the Consultant's opinion the contractor has made reasonable efforts to provide supplementary information and to revise the breakdown in accordance with the discussions with the Consultant. Such authorization for payment shall not be deemed to give approval of the cost breakdown for future payments and every effort shall be made by the contractor to provide the breakdown satisfactory to the Consultant before any subsequent payment requests.

#### 1.6 Contractor's Use of Site

- .1 Do not unreasonably encumber site with materials or equipment.
- .2 Move stored products or equipment which interferes with operations of Consultants or other Contractors.



- .3 Obtain and pay for use of additional storage or work areas needed for operations.

#### 1.7 Codes and Standards

- .1 Perform work in accordance with the Ontario Building Code (OBC), the Ontario Electrical Code, and any other code of provincial or local application provided that in any case of conflict or discrepancy the more stringent requirements shall apply.
- .2 Meet or exceed requirements of contract documents, specified standards, codes and referenced documents.
- .3 Where requirements of this specification exceed those of above mentioned standards, this specification shall govern.
- .4 Comply with all municipal, provincial and federal laws, regulations, and by-laws including, but not limited to, those concerning the environment and the disposal of waste. The contractor shall inform itself of such requirements.

#### 1.8 Location of Equipment and Fixtures

- .1 Location of equipment, fixtures and outlets indicated or specified are to be considered as approximate.
- .2 Locate equipment, fixtures and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.
- .3 Inform Consultant of impending installation and obtain his approval for actual location.
- .4 Submit field drawings to indicate relative position of various services and equipment when required by Consultant.

#### 1.9 Cutting, Fitting and Patching

- .1 X-ray floors and structural walls before cutting to locate existing rebar and conduits and to obtain Owner's approval for proposed cutting or core drilling.

- .2 Execute cutting, excavation, fitting and patching required to make work fit properly.
- .3 Where new work connects with existing and where existing work is altered, cut, patch and make good to match existing work.
- .4 Make cuts with clean, true, smooth edges. Make patches inconspicuous in final assembly. Provide sleeves at penetrations.
- .5 Fit work airtight to pipes, sleeves, ducts and conduits.

1.10 Shutdowns of  
Services and  
Systems

- .1 All shut-downs to be in accordance with Sections 00 and 01.
- .2 Contractors are to verify with Owner before making any connection to any existing systems. This will ensure that (1) the Owner is aware that work will be done on a system and (2) that the contractor is working on a system that is working when he starts his work.

1.11 Alterations,  
Additions or Repairs  
to Existing Building

- .1 Execute work with least possible interference or disturbance to occupants, public and normal use of premises. Arrange with Consultant to facilitate execution of work.
- .2 Where security has been reduced by work of Contract, provide temporary means to maintain security.
- .3 Where elevators, dumbwaiters, conveyors or escalators exist in building, only those assigned for Contractor's use may be used for moving men and materials within building. Protect walls of passenger elevators, to approval of Consultant before use. Accept liability for damage, safety of equipment and overloading of existing equipment.
- .4 Provide temporary dust screens, barriers, warning signs in locations where renovation and alteration work is adjacent to areas used by public or government staff.

- |  |    |  |
|--|----|--|
| <u>1.12 Additional Drawings</u>        | .1 | Consultant may furnish additional drawings to assist proper execution of work. These drawings will be issued for clarification only. Such drawings shall have same meaning and intent as if they were included with plans referred to in contract documents.               |
|  |    |  |
| <u>1.13 Taxes</u>                      | .1 | Pay all taxes properly levied by law including Federal, Provincial and Municipal.  |
|  |    |  |
| <u>1.14 Fees, Permits Certificates</u> | .1 | Pay all fees and obtain all permits (except for Municipal building permit). Provide authorities with plans and information for acceptance certificates. Furnish inspection certificates as evidence that work conforms with requirements of authority having jurisdiction. |
|  |    |  |
| <u>1.15 Explosive Actuated Devices</u> | .1 | Do not employ power guns using explosives, unless permitted expressly by the Consultant; comply with fastening requirement of CSA Z-166 (Safety Code for Explosive Actuated Tools). Ensure concrete slabs not adversely affected.  |
|  |    |  |
| <u>1.16 Examination and Site Visit</u> | .1 | Examine site and conditions likely to affect work. Submissions of tender deemed confirmation that tenderer has inspected site and is conversant with conditions.   |
|  | .2 | Extras will not be considered based on situations which could reasonably have been foreseen by a close inspection of the site.   |
|  | .3 | Prior to commencing installation of services, check the location and invert elevations of all service lines including sanitary sewer, and water mains and gas mains with local authorities.  |
|  |    |  |
| <u>1.17 Warranty</u>                   | .1 | Contractor to provide all labour and material to promptly correct defects or deficiencies in the work and the performance of the work, which appear prior to and during the one year Warranty period.  |

The Warranty is to include complete labour and material Product warranties for all Products included in the work.

- .2 The Warranty period for the corrected work is to be extended for an additional year following the correction of defects and deficiencies in the work carried out in the initial warranty period.
- .3 The start of the Warranty period for completed mechanical work shall commence on the date of substantial completion unless stated otherwise.
- .4 Certain items of equipment have extended warranties required in the specifications. Collect all agreements, guarantees, and warranty certificates and provide to the Owner.

#### 1.18 Contract

- .1 Project drawings and specifications are complimentary to this General Specification, in cases of conflict ambiguity or doubt apply to the Consultant for a ruling in writing, prior to tender closing. Once the Tender has closed the Consultant's ruling shall be final and binding, claims for extras will not be accepted.
- .2 All jobs must be complete, performed and finished in a workmanlike manner. Work and materials of an incidental nature, necessary by implication to produce the finished job as specified, shall be supplied, even when not listed or described in detail.
- .3 No deviations from the specifications or drawings will be allowed without written permission of the Consultant.

#### 1.19 As-Built Drawings by Contractor

- .1 The successful contractor shall be responsible for a complete set of as-built drawings.
- .2 A set of prints shall be kept up-to-date as the work progresses. Show all changes and deviations from the original tender documents whether they be issued change orders, site instructions or contractor's changes.
- .3 Record exactly the location of services where concealed or buried or where capped or plugged for future use. As-Built drawings shall

show all duct sizes, piping sizes, component labeling, schedules, flow rates (air and water) etc.

- .4 The Consultant shall make available the Tender Issue of the drawings. This contractor shall update these with all Change Orders, Site Instructions, and to reflect site conditions. An amount shall be held back, until these drawings are completed to the entire satisfaction of the Consultant.
- .5 The Consultant reserves the right to request a number of verifications necessary to prove the exactness of the as-built drawings.
- .6 Within two weeks of achieving Substantial Completion of the project, the contractor shall turn over a complete set of as-built drawings (marked up white prints, in red ink) to the Consultant. The Consultant shall incorporate information received via the as-built drawings onto a set of Record Drawings for the client.

#### 1.20 Definitions

- .1 "Acceptable Material": means that item named and specified by catalogue number forms parts of specification and sets standard regarding performance, quality of material and workmanship, and when used in conjunction with a referenced standard, shall be deemed to supplement the standard. Equipment proposed shall be one of the named suppliers. Approval for other products/suppliers shall be obtained from the Consultant prior to tender closing. Such approval must be in writing.
- .2 "Equal to", or "or equal": Means that other products meeting the same specification as the named product will be accepted as equal without prior approval as an alternate. The Consultant's decision will be final as to whether the product meets the specification in all respects, and if not, the named product shall be supplied. In general, the building systems have been engineered around those products named in the equipment schedules as shown on the drawings. In the event that a product, identified in this specification as an 'Equal', is selected for use by this contractor any additional costs resulting from the use of this equivalent product shall be borne by the responsible contractor. No extras will be considered.

1.21 Responsibility  
for Trial Usage

- .1 Obtain written permission from Owner to start and test permanent equipment and systems prior to acceptance by the Consultant.
- .2 Consultant or Owner may use equipment and systems for test purposes prior to acceptance. Supply labour, material and instruments required for testing.

1.22 Shop  
Drawings

- .1 General:
  - .1 The Consultant shall review or take other appropriate action on the Contractor's submittals, such as shop drawings, product data, samples and other data, which the Contractor is required to submit, but only for the limited purposes of checking for conformance with the design concept and the information shown in the Construction Documents. This review shall not include review of the accuracy or completeness of details, such as quantities, dimensions, weights or gauges, fabrication processes, construction means or methods, coordination of the work with other trades or construction safety precautions, all of which are the sole responsibility of the Contractor.

The Consultant's review shall be conducted with reasonable promptness while allowing sufficient time in the Consultant's judgment to permit adequate review. Review of a specific item shall not indicate that the Consultant has reviewed the entire assembly of which the item is a component. The Consultant shall not be responsible for any deviations from the Construction Documents not brought to the attention of the Consultant in writing by the Contractor. The consultant shall not be required to review partial submissions or those for which submissions of correlated items have not been received.
  - .2 Submit to the Consultant, for review, shop drawings, product data and samples specified. Until submission is reviewed, work involving relevant product may not proceed.
- .2 Shop Drawings:
  - .1 Drawings by Contractor, Sub-contractor, supplier or distributor, shall be prints which illustrate appropriate portion of work; showing fabrication, layout, setting or erection

- details as specified in appropriate sections. Submit for review with all submission requirements identified in the specification.
- .2 Identify details by reference to sheet and detail numbers shown on contract drawings.
  - .3 Maximum sheet size 44"x34" (1120 mm x 8600 mm).
- .3 Ductwork, piping, and sprinkler drawings:
- .1 Sprinkler fabrication drawings shall be prepared on AutoCAD 2008 or later edition. The Consultant will provide electronic background drawings to the successful contractor on request. Sprinkler drawings shall be submitted as outlined in the specification.
  - .2 The sheetmetal contractor shall prepare ductwork and equipment interference drawings on AutoCAD 2008 or later edition. These drawings shall show all equipment (above the ceiling or floor mounted), plumbing, piping, cable tray, pneumatic tube and sheetmetal layouts as required to fully coordinate the ductwork installation with all other trades to avoid interference. Adjust duct aspect ratios as required to accommodate other services. These drawings shall be prepared and submitted, for review by the Consultant, prior to any sheetmetal fabrication. Six (6) sets of prints shall be submitted for review.
- .4 Product Data:
- .1 Certain specification sections specify that manufacturer's standard schematic drawings, catalogue sheets, diagrams, schedules, performance charts, illustrations and other standard descriptive data will be accepted in lieu of shop drawings.
  - .2 Above will only be accepted if they conform to the following:
    - .1 Delete information which is not applicable to the project.
    - .2 Supplement standard information to provide additional information applicable to project.
    - .3 Show dimensions and clearances required.
    - .4 Show performance characteristics and capacities.
    - .5 Show wiring diagrams and controls.
    - .6 For items with electrical connections, show voltage, phase and power (HP, watts, amps).

- .5 Coordination of submissions:
  - .1 Review shop drawings, product data and samples prior to submission.
  - .2 Verify field measurements; field construction criteria; catalogue numbers; and similar data.
  - .3 Coordinate each submission with requirements of work and contract. Individual shop drawings will not be reviewed until all related drawings are available. The contractor shall submit all shop drawings specified in a section in one submission. Multiple shop drawing submissions for a specification section shall not be acceptable. In the event that shop drawings are submitted piece meal (multiple submissions) within a specification section, the shop drawings shall be retained by the Consultant until all shop drawings from that section have been received for review.
  - .4 Contractor's responsibility for errors and omissions in submission is not relieved by the Consultant's review of submittals.
  - .5 Contractor's responsibility for deviations in submission from requirements of contract documents is not relieved by the Consultant's review of the submission, unless the Consultant gives written acceptance of specified deviations.
  - .6 Notify the Consultant, in writing at time of submission, of deviations from requirements of contract documents.
  - .7 After the Consultant's review, distribute copies.
- .6 Submission requirements:
  - .1 Schedule submissions at least 15 working days before dates reviewed submissions will be needed.
  - .2 Electronic shop drawing submissions are acceptable with the following conditions:
    - .1 The shop drawings are submitted in pdf format with a transmittal and include the contractor's review stamp.
    - .2 The page size cannot exceed 8.5"x11" and must be fully legible.

In the event that the electronic submission cannot conform to the requirements identified above, the Contractor shall submit six (6) sets of hard copies for review.
  - .3 On each submission sheet, ensure clear space 3" x 3" for review stamp (e.g. letter size data sheet on legal size paper).
  - .4 Accompany submissions with transmittal letter containing:



- .1 Date; project title and number; Contractor's name and address; number of each shop drawing, product data and sample submitted.
- .2 Other pertinent data.
- .5 Submissions shall include:
  - .1 Date and revision dates; project title and number.
  - .2 Name of: Contractor; sub-contractor; supplier; manufacturer.
  - .3 Identification of product or material.
  - .4 Relation to adjacent structure of materials.
  - .5 Field dimensions, clearly identified as such.
  - .6 Specification section numbers
  - .7 Applicable standards, such as CSA or CGSB numbers.
  - .8 Contractor's stamp, initialled or signed, certifying review of submission, verification of field measurements and compliance with contract documents.

### 1.23 Maintenance Manuals

- .1 One draft copy of the proposed maintenance manual shall be submitted for review within four (4) weeks of the review of shop drawings.
- .2 The Consultant may withhold progress payments until such time as the draft copy is received.
- .3 Once the draft copy has been reviewed by the Consultant, submit to Consultant two (2) hardcopies and one digital copy on USB of Operating and Maintenance Data incorporating the revisions as necessary, made up as follows:
  - .1 Bind data in vinyl hard covered, three (3) ring, loose leaf binder for 215 x 280 mm size paper.
  - .2 Enclose title sheet, labelled "Operating and Maintenance Data Manual", project name, date and list of contents.
  - .3 Organize contents into applicable sections of work to parallel project specification breakdown. Mark each section by labelled tabs protected with celluloid covers fastened to hard paper dividing sheets.
- .4 Include following information plus data specified.
  - .1 Maintenance instruction for finished surface and materials.
  - .2 Copy of hardware and paint schedules.

- .3 A clear copy of shop drawings for all equipment.
  - .4 A schedule for all equipment summarizing the Reference Number, Make, Model, Serial Number, Capacity, Electrical Data, etc.
  - .5 Description, operation and maintenance instructions for equipment and systems, including complete list of equipment and parts list. Indicate nameplate information such as make, size, capacity, serial number.
  - .6 Names, addresses and phone number of sub-contractors and suppliers.
  - .7 Guarantees, warranties and bonds showing:
    - .1 Name and address of projects.
    - .2 Guarantee commencement date (date of Final Certificate of Completion).
    - .3 Duration of guarantee.
    - .4 Clear indication of what is being guaranteed and what remedial action will be taken under guarantee.
    - .5 Signature and seal of Contractor.
  - .8 Additional material used in project listed under various sections showing name of manufacturer and source of supply.
- .5 Neatly type lists and notes. Use clear drawings, diagrams or manufacturer's literature.

#### 1.24 Demolition

- .1 Full extent of demolition is not illustrated on drawings. Where indicated on the drawings and where walls and ceilings are shown to be removed, disconnect, cap, and remove all services and equipment. All services and equipment which have become redundant under the contract shall be removed. All items removed during demolition shall be removed from the site, unless noted otherwise. All materials to be removed from site shall be disposed of in accordance with all Provincial codes and regulations. Consultant shall be notified if contractor is unsure of services to be removed or capped.
- .2 The Contractor shall remove and reinstate to match existing, any items or services which interfere with demolition and new construction.
- .3 The Contractor is responsible for immediate reconnection of any services which are to remain and which have been disconnected during the course of demolition or construction.

- .4 Where existing materials are shown to be removed and reused, the Contractor is responsible for their removal, storage, cleaning to the satisfaction of the Consultant, and reinstallation.
- .5 The Contractor shall be responsible for protecting all equipment and services to remain during the course of demolition. Should any damage occur, it shall be the Contractors responsibility to supply and install new services and equipment.
- .6 Maintain adequate structural support for services and equipment to remain during the course of demolition.
- .7 Remove, store safely, clean to the satisfaction of the Consultant, and reinstall grilles and diffusers where ceiling systems are disturbed.

1.25 Contractor  
Quality Assurance  
Program

- .1 The Contractor is solely responsible for the control, charge and supervision of construction methods, techniques, sequences and procedures, and for safety precautions and programs required in connection with the work.
- .2 The Contractor is responsible for the discovery and correction of deficiencies, errors and omissions in the execution and performance of the work and for the preparation of submissions, reports, relating to the work.
- .3 The Contractor is responsible for providing the appropriate quality assurance program to ensure that the work is carried out and performs in accordance with the Contract Documents, industry standards and relevant codes and legislation. The Contractor Quality Assurance Program is to ensure the following:
  - .1 The use of qualified tradesmen, experts and professionals with the level of skill and experience required for the proper execution and performance of the work.
  - .2 The level of direction, supervision and inspection required for the proper execution and performance of the work.
  - .3 The level of co-ordination between trades, field conditions, material requirements and product requirements required for the proper execution and performance of the work.

- .4 The level of management required for the quality assurance program to operate effectively so that deficiencies, errors and omissions in the work are identified by the Contractor on a continuous basis and that corrective action is carried out promptly.
- .5 The level of management and communication required for the status of the work to be properly monitored and reported to the Owner and the Consultant.

- .4 Project observation reports of the work by the Consultant and Owner are not to be considered part of the Contractor Quality Assurance Program.
- .5 The review of Contractor prepared submissions (shop drawings, reports, etc.) by the Consultant and Owner are not to be considered part of the Contractor Quality Assurance Program, and do not alleviate the Contractors responsibility to meet all documented requirements.

1.26 Progress  
Payments

- .1 Payment requests are to be submitted on a system by system, area by area, basis as per the agreed cost breakdown.
- .2 Date applications for payment for the last day of the monthly payment period and ensure amount claimed is for value proportionate to amount of Contract, of Work performed, and Products delivered to Place of Work at that date. Payment will not be authorized for materials that are not delivered to site at date of submission of claim.
- .3 Payment for work that requires field testing such as pressure and leak tests; approval from authorities having jurisdiction; or approval from specified experts such as seismic control; will be limited to 90% of the value of the labour and material of such work until such time as the testing is completed, witnessed, and recorded; the authorities having jurisdiction have given their approval for the work; or the specified experts have provided their written verification of the installations.
- .4 Payment for work that must prove performance through start-up, TAB, and commissioning activities will be limited to 98% of the value of the labour and material for each system until such time as

the equipment manufacturer's start-up tests are complete and reports submitted and the equipment is in satisfactory operation.

- .5 Payment against the Commissioning allowance will not commence until after the TAB is complete, and will be paid in proportion to the completion of the defined commissioning activities.

1.27 Substantial  
Performance

- .1 The Contractor's Application for Substantial Performance is to include documentation that supports the Contractor's certification that the work has been carried out and is performing in accordance with Contract Documents and is "ready for use for the purpose intended".
- .2 The following documentation is required on a system-by-system basis in conjunction with the Contractor's Status Report and Progress Payment Request:
  - .1 Contractor's Status Report.
  - .2 Component and System Test Reports.
  - .3 Distribution System Balancing and Capacity Test Reports.
  - .4 Local Authority Inspection Reports (Building Inspection, Plumbing Inspection, etc.).
  - .5 Provincial Government Inspection Reports (TSSA, Pressure Piping, Boilers, etc.).
  - .6 Distribution and Equipment Support System. Engineering Certificate.
  - .7 Equipment Operation and Capacity Test Reports.
  - .8 Equipment Manufacturer Certification of Approval of Installation and Operation.
  - .9 Commissioning Verification Reports of proper (fully automatic) operation and performance, under all load conditions (part load, full load, seasonal).
  - .10 Commissioning Verification Reports of proper (fully automatic) operation and performance, under upset conditions (power failure, emergency power, device failure, control failure).
  - .11 Completion of Training activities to an extent which allows the Owner to undertake operation and maintenance of mechanical systems.
  - .12 Turnover of completed Record Drawings to the Owner.
  - .13 Turnover of completed Maintenance Manuals to the Owner.
  - .14 Turnover of specified spare parts.
  - .15 Contractor's Warranty Certificate.

- .16 Product Manufacturer's Warranty and Extended Warranty Certificates.
- .17 Contractor's Report on work presently identified as being incomplete and the schedule to complete the work.
- .18 Report on work presently identified as being deficient and the schedule to carry out corrective work.
- .19 Report on Product Warranty start dates for work which is incomplete or Deficient.

1.28 Construction  
Drawings &  
Specifications

- .1 Following execution of the contract, an "Issued for Construction" revision of the drawings and specifications, which incorporates addenda issued during the tender period, will be prepared by the Consultant and provided to the contractor for their review. The contractor shall review the "Issued for Construction" drawings and specifications to confirm that all addenda are included and confirm the contractor's acceptance in writing back to the Consultant.
- .2 The "Issued for Construction" drawings and specifications will be provided to the contractor for his initial review following execution of the contract. No claims for delays by the contractor will be considered relating to the issuance of Construction documents.
- .3 Following acceptance of the "Issued for Construction" drawings and specifications by the contractor, the Consultant will supply the following items to the Prime Consultant for distribution to the contractor:
  - .1 Email electronic (PDF) files of the entire set of "Issued for Construction" drawings and specifications.
  - .2 One (1) CD containing the entire set of "Issued for Construction" drawings and specifications in electronic (PDF) files.

1.29 Work Schedule

- .1 Prior to first application for payment, provide a schedule showing anticipated progress stages and final completion of work.
- .2 Work schedule shall be in sufficient detail to allow cross referencing to the progress claim breakdown.
- .3 Submit and updated schedule monthly with the progress payment claim.

END OF SECTION

1.1 General  
Requirements

- .1 Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.

1.2 Definitions

- .1 "Provide" means supply, install and connect.
- .2 "Approved" means approved in writing by Consultant.
- .3 "Consultant" means the person or entity engaged by the Owner and identified as such in the Agreement. The Consultant is the Architect, the Engineer or entity licensed to practice in the province or territory of the Place of the Work.
- .4 "Manual" means Operations and Maintenance manual.
- .5 "Engineer" means Professional Engineer licensed to practice in the province or territory of the Place of the work with a Certificate of Authorization to provide professional engineering services to the public.

1.3 Maintenance  
Materials

- .1 Provide maintenance materials as called for in these specifications.

1.4 Instruction of  
Operating Staff

- .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 aspects of its care and operation.
- .4 Provide instruction during regular work hours prior to acceptance and turn-over to operating staff for regular operation.

- .5 Use operation and maintenance data manual for instruction purposes. On completion of instruction, turn manual over to Owner.

1.5 Voltage  
Regulation

- .1 Electrical equipment including all chillers and motors for any equipment provided by this contractor shall operate normally under local power quality conditions typical to the area in which the project is located. As a minimum, equipment shall operate normally within the Extreme range of voltage conditions per CSA CAN3-C235-83 at the customer's main electrical service entrance, ie, between 306/530V and 367/635V.
- .2 If the proposed equipment is unable to operate normally within the voltage range as described above, provide multi-tap electronic voltage regulating transformer system as necessary to suit the input voltage operating range requirements of the equipment. Voltage regulating system shall be complete with all electrical power and control components as required for a complete working system, and this contractor shall provide all field wiring and connections for power and controls to suit. Ensure equipment fits within the service space allocated on the drawings as no additional provisions will be made to accommodate.

1.6 Electric Motors,  
Equipment and  
Controls

- .1 The electrical contractor shall be responsible to supply all motor starters and disconnect switches for all motors for the project, all line voltage wiring to starters and starters to the motors except on pre-wired packaged equipment. Some control wiring for mechanical equipment is specified in the Controls specifications. Refer to Electrical specifications for quality of materials and workmanship.
- .2 All electrical equipment supplied by the Mechanical contractor (Variable frequency Drives, control panels,...) and installed in a sprinklered building or within mechanical rooms with hydronic systems shall be protected by suitable water resistant casing to minimize the risk of damage from water discharge. If the manufacturer's equipment is not protected by a suitable casing or



enclosure, supply and install suitable non-combustible hoods or shields to protect the equipment.

.3 Motors:

- .1 Provide motors for mechanical equipment as specified.
- .2 If delivery of specified motor will delay delivery or installation of any equipment, install an acceptable motor for temporary use. Final acceptance of equipment will not occur until specified motor is installed.
- .3 All motor efficiencies shall be in accordance with the OBC 2012 supplementary standard SB-10 and ASHRAE 90.1-2013.
- .4 Where variable speed drives are controlling the motor, all motors shall be coordinated with the selected variable frequency drive requirements and shall be marked for inverter duty as per CSA C22.2 No.100.
- .5 All motors 25 HP and larger shall have thermistors installed.

1.7 Painting

- .1 Apply at least one coat of corrosion resistant primer paint to supports, and equipment fabricated from ferrous metals, and all pipework.
- .2 Touch-up all damaged equipment to match original manufacturer's paint quality and colour.

1.8 Equipment Requirements and Installation

- .1 Permit equipment maintenance and disassembly by use of unions or flanges to minimize disturbance to connecting piping and duct systems and without interference from building structure or other equipment.
- .2 Provide accessible means for lubricating equipment including permanent lubricated bearings.
- .3 Mount base mounted equipment on chamfered edge housekeeping pads a minimum of 88 mm high and 50 mm larger than equipment dimensions all around, or larger as directed by the seismic design engineer. Concrete to be provided under Division 3, but this contractor shall layout and co-ordinate bases for all his equipment.
- .4 Pipe drain lines to drains.

- .5 Provide drain hose connection with shut-off valve and cap at all low points in hydronic systems.
- .6 Line up equipment, rectangular cleanouts and similar items with building walls wherever possible.

1.9 Protection of  
Openings

- .1 Protect equipment and system openings from dirt, dust and other foreign materials.

1.10 Thermometers,  
Pressure Gauges

- .1 General:
  - .1 Locate direct reading thermometers and gauges for reading from floor or platform.
  - .2 Provide remote reading thermometers and gauges where direct reading instruments cannot be satisfactorily installed.
  - .3 Locate engraved lamaroid nameplate as specified in Section 23 05 53 - Identification, identifying medium adjacent to thermometers and gauges.
  - .4 Thermometers shall be selected to operate at mid-point on their scales. The thermometer pressure rating shall exceed the hydronic system pressure relief valve setting.
  - .5 Pressure Gauges shall be selected to operate at mid-point on their scales. Should the hydronic system pressure relief valve setting exceed the gauge's maximum pressure display, the gauges shall instead be selected with a pressure rating of not less than the system's pressure relief valve setting.
  - .6 Install thermometers and pressure gauges as shown on the schematic and general arrangement drawings.
- .2 Duct Thermometers:
  - .1 Shall be 125 mm (5") dial, bimetal thermometer with stainless steel case, dual F/C scales, range selected to be not more than twice working temperature.
  - .2 Supply back connected or bottom connected to suit application, with a minimum 6" stem length for pipework and 1/2 diameter length for ductwork systems (24" maximum).
  - .3 Where thermometers are located at higher than 2100 mm (7'0") above floor or platform height, or where otherwise required to permit easy reading, use adjustable angle type thermometers.

- .3 Pipe Thermometers:
  - .1 Shall be industrial variable angle liquid filled type of 225 mm (9") length (CAN/CGSB 14.4) with stainless steel case.
  - .2 Provide stainless steel or brass thermal wells for all pipework applications with lagging type to be used for insulated piping.
- .4 Pressure Gauges:
  - .1 All gauges to be in accordance with ANSI B40.1 Grade "1A", with minimum 100 mm (4") case, full size phosphor bronze bourdon tube, silver brazed tip and socket, 1/4 NPT lower connection, rotary type bushed movement, dual PSI and kPa scale, range selected between 1.25 and 2 times working pressure, unless hydronic system pressure relief valve setting is higher as described previously in this section. Provide 1/4" bar stock needle valve.
  - .2 Gauges shall be liquid filled for all services except steam. For steam applications supply 6 mm pigtail siphons in addition to the needle valves.
  - .3 Accuracy to be not less than 1% gauges.
  - .4 Pressure Gauges to be registered with Provincial Boiler and Pressure Vessel Safety Branches with C.R.N. number where they are installed on pressure vessels or registered systems, as required by TSSA.
- .5 Shop Drawings: Submit detailed schedules for all gauges and thermometers clearly indicating location, working pressure, full scale range, and model.
- .6 Acceptable Material: Winters, Pitanco, H.O. Trerice.

#### 1.11 V-belt Drives

- .1 Fit reinforcing belts in sheave matched to drive. Multiple belts on unit to be matched set.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys.
- .3 For motors 0.25 kW to 7.5 kW: standard adjustable pitch drive sheaves, having + or -10% range. Use mid-position of range for specified rpm.
- .4 For motors over 7.5 kW: Sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item

concerned. Provide replacement sheaves of correct size and belts if required to suit balancing, at no additional cost.

- .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 Tension belts to manufacturer's recommendations before start up and after first 100 hours of operation.
- .8 Provide one spare set of V-belts for each piece of machinery.

#### 1.12 Guards

- .1 Provide guards for all exposed drives.
- .2 Guards for drives shall have:
  - .1 Expanded metal screen welded to 25 mm steel angle frame.
  - .2 1.2 mm thick galvanized sheet metal tops and bottoms.
  - .3 Removable sides for servicing.
  - .4 38 mm diameter holes on both shaft centres for insertion of tachometer.
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Install belt guards to permit movement of motors for adjusting belt tension.
- .5 For flexible couplings, provide removable, "U" shaped, 2.7 mm thick galvanized frame and 1.2 mm thick expanded mesh face.
- .6 Provide 19 mm galvanized mesh wire, expanded metal screen on inlet or outlet of exposed fan blades such that net free area of guard is not less than that of fan openings.

#### 1.13 Pipe Hangers and Supports

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1-1989.

- .2 Set inserts in position in advance of concrete work. Use grid system in equipment rooms.
- .3 Support from top of structural members. Where structural bearings do not exist or inserts are not in suitable locations, suspend hangers from steel channels or angles. Provide supplementary structural members. Obtain approval before using vertical expansion shields. Do not suspend from metal deck. Anchoring of piping and equipment shall be to manufacturer's recommendations.
- .4 Adjustable clevis type hanger: on all sizes of pipes.
  - .1 Acceptable Materials: Myatt, Grinnell.
  - .2 Rigid hangers: on heating water, steam, condensate, domestic hot water, when ratio of pipe expansion to hanger rod length does not exceed 1:24.  
Minimum rod length: 300 mm.
  - .3 Swing hangers: on heating water, steam, condensate, domestic hot water, when ratio of pipe expansion to hanger rod length does not exceed 1:6.  
Minimum rod length: 300 mm.
  - .4 Use pipe rollers complete with bracing when ratios as above cannot be maintained.
  - .5 For piping except as noted above, minimum rod length to be 150 mm.
- .5 Provide spring hangers to offset expansion on horizontal runs which follow long vertical risers.
- .6 Govern spacing between pipe rack supports using smallest pipe size.
- .7 Use rod diameters and spacing for pipe supports as shown in table with the following exceptions.
  - .1 Support plumbing piping in accordance with more stringent requirements of authorities having jurisdiction. Canadian Plumbing Code, Provincial code.
  - .2 Support NPS 12 gas pipe every 1.8 metres. Support NPS 12 copper pipe every 1.5 metres.
  - .3 Support flexible joint roll grooved pipe in accordance with table below, but not less than one hanger for each joint.
  - .4 Support plastic piping in accordance with manufacturer's recommendations.

Pipe Size NPS	Rod Diameter	Maximum Steel	Spacing Copper
up to 20	10 mm	2.1 m	1.8 m
25	10 mm	2.1 m	1.8 m
30	10 mm	2.1 m	1.8 m
40	10 mm	2.7 m	2.4 m
50	10 mm	3.0 m	2.7 m
65	10 mm	3.6 m	3.0 m
75	10 mm	3.6 m	3.0 m
90	10 mm	3.9 m	3.3 m
100	16 mm	4.2 m	3.6 m
125	16 mm	4.8 m	
150	22 mm	5.1 m	
200	22 mm	5.7 m	
250	22 mm	6.6 m	
300	22 mm	6.9 m	

- .8 Place support within 300 mm of each horizontal elbow.
- .9 Hangers shall be 3 piece minimum standard, i.e. attachment, rod, pipe attachment.
- .10 Mild steel wall hooks may be used to support non-expanding piping. Allow 25 mm minimum clearance for insulated pipe.
- .11 Provide riser clamps as required and where shown.
- .12 On un-insulated copper piping use copper or copper plated hangers or 6 mm lead crimped to hanger between copper and ferrous hanger.
- .13 Provide saddles for insulated pipe and prefabricated insulation shields with high density insulation with vapour barriers for cold water piping.
- .14 Offset hanger pipe and structural attachments in such a manner that rod is vertical when piping is hot.
- .15 Adjust hanger rods to equalize load.
- .16 Pipes to be supported on flat roof using interlocking, UV stabilized polypropylene support equal to Quick-Block by "A Better Idea Inc.", Miro Industries, or equal. Provide support extension with unistrut

as required to suit piping systems, with clamp or clevis hangers as required. All metal components shall be galvanized steel. Provide rollers on support system for straight pipe runs longer than 10 meters. Anchor to roof structure as required to suit seismic restraint design.

1.14 Pipe Expansion  
/Anchoring

.1

Provide for expansion and contraction of pipe risers and horizontal distribution mains for all heating, cooling, steam, steam condensate, and steam relief piping systems, in accordance with good Engineering principles. Provision shall be by way of offsets or U bends wherever practical and expansion bellows shall only be used where space does not permit pipe offsets to occur.

The contractor shall provide for all required anchoring as either shown on the drawings or as required to restrict pipe movement at those points and all piping to move in a controlled manner with other components of this system installed (i.e. expansion joints, pipe guides, etc.)

The contractor shall provide an engineered details and layout plans of the pipe anchor for each respective piping system. The engineered details and layout plans shall be sealed and signed by a Professional Engineer, licensed in the Province of Ontario. The contractor shall be responsible for all force calculations that are required for the anchor design.

Submit shop drawing details of expansion and anchoring systems for the Consultant's review prior to construction. Include a full piping layout indicating locations of each piping system expansion joint, pipe guides, and pipe anchor.

1.15 Sleeves and  
Fire Stopping  
Pipe Penetrations

.1

Firestopping system must be ULC/Warnock Hersey approved.

.2

Install sleeves where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.

.3

Sleeve material:

.1 Shall be Schedule 40 black steel. Where sleeves extend above finished floor, sleeves to have annular fins

- continuously welded on at mid-point. Before installation of exterior sleeves, paint exposed surfaces with a heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .2 Sleeves installed for future uses shall be fire stopped as a blank opening listed system in order to provide the same fire rating as the assembly.
  - .3 One step cast-in-place sleeve and fire stop assemblies are an acceptable alternative to steel sleeving systems. Cast-in-place sleeve shall be supplied with post pour threaded extension to extend the top of the sleeve above the finished slab. Acceptable material: Hilti CP680.
  - .4 Sleeve Installation:
    - .1 For concrete walls, masonry walls, and concrete floors slab on grade: Terminate sleeve flush with finished surface.
    - .2 All other floors: Terminate sleeve 50 mm above finished floor.
  - .5 Sealing:
    - .1 Floor Slabs: Seal with fire retardant, waterproof non-hardening material.
    - .2 Foundation Walls: Use Link-Seal modular seals.
  - .6 Firestopping:
    - .1 When penetration element pass through a fire rated separation floor or wall; maintain fire rating integrity.
    - .2 Provide free annular space according to the corresponding listed system to be used.
    - .3 Apply fire stop material according to the installation procedure corresponding to the selected listed systems used.
    - .4 Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.
    - .5 Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.
    - .6 Ensure no metal to metal contact where pipe passes through sleeve.



- .7 Always submit specific firestop details of all penetration types as a shop drawing for review by the Consultant prior to construction, showing approval number and installation details.
- .8 For those firestop applications that exist for which no ULC or cUL tested system is available through a manufacturer; a manufacturer's engineering judgment derived from similar ULC or cUL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineer judgment drawings must follow requirements set forth by the International Firestop Council (September 7, 1994).
- .9 A manufacturer's direct representative (not distributor or agent) to be on site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures. This will be done per manufacturer's written recommendations published in their literature and drawing details.

1.16 Acceptable  
Fire Stop  
Manufacturers

- .1 Subject to compliance with through penetration firestop systems listed in U.L.C. Fire Resistance Directory - Volume III or UL Products Certified for Canada (cUL) Directory, provide products of the following manufacturers as identified below:
  - .1 Hilti (Canada) Limited, Mississauga, Ontario  
1-800-353-4458
  - .2 Tremco Sealants & Coatings, Beachwood, Ohio  
(216) 292-5000
  - .3 3M Fire Protection Products, St. Paul, Minnesota  
(612) 736-0203
  - .4 Other manufacturers listed in the U.L.C Fire Resistance Directory - Volume III or UL Products Certified for Canada (cUL) Directory.

1.17 Firestop  
Materials

- .1 Use only firestop products that have been ULC or cUL tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.

- .2 Cast-in place firestop devices are installed prior to concrete placement for use with non-combustible and combustible plastic pipe (closed and open piping systems) penetrating concrete floors, the following products are acceptable:
  - .1 Hilti CP 680 Cast-In Place Firestop Device
  - .2 Equivalent products listed in the U.L.C. Fire Resistance Directory - Volume III or UL Products Certified for Canada (cUL) Directory).
- .3 Sealant or caulking materials for use with non-combustible items including steel pipe, copper pipe, rigid steel conduit and electrical metallic tubing (EMT), the following products are acceptable:
  - .1 Hilti FS-ONE Intumescent Firestop Sealant
  - .2 Hilti CP 604 Self Leveling Firestop Sealant
  - .3 Hilti CP 620 Fire Foam
  - .4 3M Fire Stop Sealant 2000
  - .5 3M Fire Barrier CP25 WB
  - .6 Tremco Tremstop Fyre-Sil Sealant
  - .7 Equivalent products listed in the U.L.C. Fire Resistance Directory - Volume III or UL Products Certified for Canada (cUL) Directory
- .4 Sealants or caulking materials for use with sheet metal ducts, the following products are acceptable:
  - .1 Hilti CP 601s Elastomeric Firestop Sealant
  - .2 Hilti CP 606 Flexible Firestop Sealant
  - .3 Hilti FS-ONE Intumescent Firestop Sealant
  - .4 Hilti CP 604 Self Leveling Firestop Sealant
  - .5 Equivalent products listed in the U.L.C. Fire Resistance Directory - Volume III or UL Products Certified for Canada (cUL) Directory
- .5 Intumescent sealants or caulking materials for use with combustible items (penetrants consumed by high heat and flame) including insulated metal pipe, PVC jacketed, flexible cable or cable bundles and plastic pipe, the following products are acceptable.
  - .1 Hilti FS-ONE Intumescent Firestop Sealant
  - .2 Hilti CP 620 Fire Foam
  - .3 3M Fire Barrier CP25 WB
  - .4 Tremco Tremstop WBM Intumescent Firestop Sealant
  - .5 Equivalent products listed in the U.L.C. Fire Resistance Directory - Volume III or UL Products Certified for Canada (cUL) Directory

- .6 Intumescent sealants, caulking or putty materials for use with flexible cable or cable bundles, the following products are acceptable:
  - .1 Hilti FS-ONE Intumescent Firestop Sealant
  - .2 Hilti CP 618 Firestop Putty Stick
  - .3 Hilti CP 620 Fire Foam
  - .4 3M Fire Barrier CP25 WB
  - .5 Tremco Tremstop WBM Intumescent Firestop Sealant
  - .6 Equivalent products listed in the U.L.C Fire Resistance Directory - Volume III or UL Products Certified for Canada (cUL) Directory
- .7 Non curing, re-penetrable intumescent sealants, caulking or putty materials for use with flexible cable or cable bundles, the following products are acceptable:
  - .1 Hilti CP 618 Firestop Putty Stick
  - .2 Equivalent products listed in the U.L.C Fire Resistance Directory - Volume III or UL Products Certified for Canada (cUL) Directory
- .8 Wall opening protective materials for use with U.L.C listed metallic and specified nonmetallic outlet boxes, the following products are acceptable:
  - .1 Hilti CP 617 Firestop Putty Pad
  - .2 Equivalent products listed in the U.L.C Fire Resistance Directory - Volume III or UL Products Certified for Canada (cUL) Directory
- .9 Firestop collar or wrap devices attached to assembly around combustible plastic pipe (closed and open piping systems) tested to 50 Pa. differential, the following products are acceptable:
  - .1 Hilti CP 642 Firestop Collar
  - .2 Hilti CP 643 Firestop Collar
  - .3 Hilti CP 645 Wrap Strips
  - .4 3M Fire Barrier PPD Plastic Pipe Device
  - .5 Equivalent products listed in the U.L.C Fire Resistance Directory - Volume III or UL Products Certified for Canada (cUL) Directory
- .10 Materials used for large size/complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:

- .1 Hilti FS 635 Trowelable Firestop Compound
  - .2 Hilti FS 657 FIREBLOCK
  - .3 Hilti CP 620 Fire Foam
  - .4 3M Firestop Foam 2001
  - .5 3M Fire Barrier CS-195 Composite Sheet
  - .6 Equivalent products listed in the U.L.C Fire Resistance Directory - Volume III or UL Products Certified for Canada (cUL) Directory
- .11 Non curing, re-penetrable materials used for large size/complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:
- .1 Hilti FS 657 FIREBLOCK
  - .2 Equivalent products listed in the U.L.C Fire Resistance Directory - Volume III or UL Products Certified for Canada (cUL) Directory

1.18 Firestop  
Field Quality  
Control

- .1 Examine sealed penetration areas with both visual inspection combined with a small proportion of destructible test (destructible tests consist of removing the fire stop material on a small surface to ensure the proper thickness of fire stop material and proper thickness/compression of backing material plus verification of all limitations of listed system used to fire stop penetration) to ensure proper installation before concealing or enclosing areas.
- .2 Keep areas of work accessible until inspection by authorities having jurisdiction.
- .3 Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.
- .4 Install a warning card that is clearly visible adjacent to all large and medium openings that may be re-penetrated. This card should contain the following information:
  - .1 Warning that the opening has been fire stop protected
  - .2 Indicate the fire stop system used (ULC or cUL)
  - .3 F rating FT rating
  - .4 Fire stop product(s) used

- .5 Person to contact and phone number in case of modification or new penetration of fire stop system

1.19 Escutcheons  
and Plates

- .1 Provide on pipes passing through finished walls, partitions, floors, and ceilings. Use chrome or nickel plated brass, split type, with set screws for ceiling or wall mounting. Inside diameter shall fit around finished pipe. Outside diameter shall cover opening or sleeve. Where sleeve extends above finished floor, escutcheons or plates shall clear sleeve extension. Secure to pipe or finished surface, but not to insulation.

1.20 Tests

- .1 Give 24 hours notice of date when tests will be made. Do not insulate or conceal work until tested and approved. Follow construction schedule and arrange for tests. Conduct tests in presence of Consultant and Owner. Bear costs including retesting and making good. Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures.
- .2 Hydraulically test heating and cooling piping systems at 1-1/2 times system operating pressure or minimum 860 kPa, whichever is greater. Maintain test pressures without loss for 4 hours unless otherwise specified.
- .3 Test domestic water, drainage and vent piping as per the requirements of the Ontario Building Code.

1.21 Access Doors

- .1 Supply access doors for furred ceilings or spaces for servicing equipment and accessories.
- .2 Access doors shall be flush mounted 600 x 600 mm for entry to service equipment unless otherwise noted. Access doors for hand entry to access valve shall be 300 x 300 mm unless noted otherwise. Doors shall open 180 degrees, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps. Steel shall be prime coated.
- .3 Supply stainless steel access doors for tiled, marble, terrazzo or special surfaces.

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	.4	Access doors in fire rated walls and ceilings shall be ULC listed to suit the fire rating.
	.5	Acceptable Materials: Acudor, Global Industries, Zurn, or Watts.
<u>1.22 Dielectric Couplings</u>	.1	Provide dielectric couplings wherever pipes of dissimilar metals are joined. Provide insulating unions for pipe sizes NPS 2 and under and flanges for pipe sizes over NPS 2. Cast brass adapters may be used where approved by the Consultant. Provide felt or rubber gaskets to prevent dissimilar metals contact.
<u>1.23 Temporary and Trial Usage</u>	.1	After approval by the Consultant, equipment may be put into service for temporary or trial usage, at the discretion of the Consultant after it is mutually agreed that such use will not damage the equipment, create safety hazards nor void applicable guarantee.
<u>1.24 Approval of Equivalent Products</u>	.1	During the tender period, any manufacturers wishing alternative products to be considered shall submit to the Consultant a written application for approval of the equivalent product. Approval of an equivalent product shall be signified by the issuance of an appropriate addendum.
	.2	No substitutes will be allowed for equipment previously approved by the Consultant for the job unless it can be shown that unforeseen delays in delivery of such equipment are causing a substantial delay in the construction schedule. The Consultant reserves the right to review such substitutions and investigate the reasons for delay with the manufacturer before approval is given.
<u>1.25 Project Personnel</u>	.1	The Project Manager and Site Foreman who are assigned to the project shall be skilled in their trade and consistent from project start to project completion. No substitution shall be permitted without the Consultant's and Owner's written acceptance/approval.

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- 1.26 Flashing .1 Do all flashing and counter flashing unless otherwise indicated where ducts and other mechanical parts are passing through weather and/or waterproofed walls, floors, roofs; all to the satisfaction of the Consultant and Architect.
- 1.27 Interference Drawings .1 Prepare large scale 1:50 layout/interference drawings and not sketches for review by the Consultant. Additionally, provide layout drawings as required for equipment bases, sleeves, and openings. Interference drawings shall clearly show all equipment (above ceiling and floor mounted) & ductwork, fully coordinated with the sprinkler, plumbing trade, electrical trade, and general contractors' trades. Whenever work occurs within an existing facility, incorporate appropriate existing systems within the coordination drawings. Refer to section 20 00 00 "Shop Drawings" for submittal requirements.
- .2 The mechanical and electrical drawings are diagrammatic and do not show details at intersection of services. Re-routing required for the clearance of all services that results in additional elbows and fitting for piping, ductwork, conduit, and cable tray within a 1500 mm radius from the diagrammatic position will not be cause for additional payment. Exact locations of runs of piping, ducts, cable trays, and conduits shall be established by the contractor in cooperation with sub-trades and other contractors prior to installation so that they will clear each other and other obstructions. In general, piping requiring uniform pitch on horizontal runs shall be given the right of way. All surface mounted components and instrumentation devices shall be carefully coordinated with the Prime Consultant and no final locations for such surface mounted items shall be chosen except with the Prime Consultant's written approval.
- 1.28 Coordination with the Controls Contractor .1 The controls shall be supplied and installed by the controls contractor except where elements such as valves, control dampers, sensor pockets, sensors, air flow stations, and water flow meters, will be supplied by the controls contractor and installed by the different mechanical sub-trades (i.e., plumbing contractor and sheet metal contractor). Of the foregoing items, control dampers, sensors

in air systems, and air flow stations shall be installed by the sheet metal contractor with the remaining items noted above being installed by the plumbing contractor. In the event that the plumbing contractor and sheet metal contractor are one in the same, the foregoing devices noted above shall be installed by that Contractor.

- .2 The supply and installation of the following components, specified but not identified as to installation responsibility shall be by the sheet metal contractor.
  - .1 Access doors in ductwork to service fire dampers, manual dampers, motorized dampers, or mechanical equipment that is installed by the sheet metal contractor.
  - .2 Access doors other than those installed in ductwork such as in walls or ceilings to access equipment installed by the sheet metal contractor.
  - .3 Painting of equipment installed by the sheet metal contractor.
  - .4 Miscellaneous equipment where ductwork is connected.

In the event that the plumbing contractor and sheet metal contractor are one in the same, the foregoing items noted above shall be installed by that contractor.
- .3 The supply and installation of the following components, specified but not identified as to installation responsibility, shall be by the plumbing contractor.
  - .1 Access doors, other than those installed in ductwork, such as in walls or ceilings to access equipment installed by the plumbing contractor.
  - .2 Painting of equipment installed by the plumbing contractor.

In the event that the plumbing contractor and sheet metal contractor are one in the same, the foregoing items noted above shall be installed by that contractor.

#### 1.29 Balancing

- .1 Balance and adjust all air handling systems including equipment, rooftop units, fans, ductwork, diffusers, registers etc. to obtain air quantities shown on drawings, within +/- 5%. Adjust fan speeds as required to achieve balance, including fitting replacement sheaves and belts as required.
- .2 Balance and adjust all heating water systems to achieve pressures and flow rates indicated. Measure flow rate across all balancing valves. For existing baseboard heaters (and other perimeter heating systems) modified under the scope of the project, perform a



water flow measurement prior to the start of the demolition, and re-instate the original flow at completion of the modifications.

- .3 Record the operating electrical characteristics of all equipment, and adjust overloads to correct values for proper protection.
- .4 Report any excessive or unusual noise and/or vibration occurring during operating of systems. Examine and report probable causes.
- .5 Compile complete data for all testing, balancing and adjusting work and submit complete reports thereon, using standard forms as illustrated in Section V, Procedures, Chapter 26 of the AABC National Standards, dated 1982.
- .6 Provide instruments and manpower to verify results of up to 30% of all reported measurements.
- .7 Acceptable Contractors:

Data Air Testing & Balancing Ltd.	Wayne Warner	(613) 283-9998 (Smiths Falls) (613) 727-9924 (Nepean)	104 Brockville St, Smiths Falls, ON K7A 3Y5	glen@dataair.ca wayne@dataair.ca
E.B. Balancing Inc.	Eve Brassard	(613) 880-9030	2282 Rue Laval, Bourget, ON K0A 1E0	ebbalancingoffice@gmail.com
Hydrauliques R&O Services Inc.	Montreal Office	(514) 739-1921	5535, rue Pare, Mont-Royal, QC H4P 1P7	info@hydrauliques.ca
Kanata Air Balancing & Engineering Ltd.	Fahd Mellal	(613) 226-1220	Unit 122, 15 Capella Court, Ottawa ON. K2E 7X1	info@kabottawa.com
Maxima Technical Services Inc.	Neil Coulombe	(613) 824-0756	18-1439 Youville Drive, Orleans, ON K1C 4M8	sales@maximatech.ca info@maximatech.ca

### 1.30 Equipment Start-up

- .1 Equipment start-up shall be supervised by a factory trained representative of the manufacturer.
- .2 A detailed start-up report shall be forwarded to the Consultant to show the tests carried out, setpoints of controls and limits, and operation of safety devices.

### 1.31 Piping and Accessories

- .1 All piping and accessories, including but not limited to strainers, suction diffusers, check valves, backflow preventers, isolation valves, flexible connections, unions, etc., shall be sized to match the pipe diameter unless otherwise indicated on the drawings, schematics, and specification. The fittings and accessories shall not match the equipment (pump, coil, A/C unit,...) pipe connection size, unless indicated otherwise.

- .2 Provide transition fittings immediately at the equipment (pump, coil, A/C unit,...) inlet and discharge connections as required to match the pipe diameter.

1.32 General  
Review Declaration

- .1 Prior to time of occupancy permit application, the following work shall be complete:
  - .1 New heating piping systems and pressure testing
  - .2 Systems required to be inspected by TSSA.
  - .3 HVAC systems.
  - .4 Fire dampers installed in accordance with ULC.
  - .5 Air and water system balancing.
  - .6 Seismic restraint systems
- .2 Prior to time of occupancy permit application, submit the following items for review:
  - .1 Municipal plumbing inspection report.
  - .2 Heating piping systems pressure test reports.
  - .3 TSSA inspection reports.
  - .4 New HVAC systems startup reports.
  - .5 Complete balancing report with no outstanding issues.
  - .6 Letters from all respective Mechanical sub-trades indicating systems have been seismically restrained in accordance with the OBC. Letters shall be authored, signed, and sealed by a Professional Engineer licensed in the province of Ontario.
- .3 Submissions shall be complete with transmittals or cover letters signed by an appropriate skilled trade. The signatory shall be registered with Skilled Trades Ontario.
- .4 The project must be substantially complete and ready for its intended use. Start up, balance and commission all systems. Ensure systems have been installed in accordance with the contract documents, manufacturer's recommendations, and industry standards as the case may be.

END OF SECTION

- 
- |                                |    |  |
|--------------------------------|----|--|
| <u>1.1 General</u>             | .1 | Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.  |
|                                |    |  |
| <u>1.2 Summary</u>             | .1 | This Section includes requirements for selective demolition and removal of Fire Protection, Plumbing, HVAC and Control components including removal of all accessories and attachments for equipment and systems.  |
|                                |    |  |
| <u>1.3 Reference Standards</u> | .1 | CSA S350 M1980 [(R2003)], Code of Practice for Safety in Demolition of Structures.   |
|                                |    |  |
| <u>1.4 Definitions</u>         | .1 | Demolish: Detach items from existing construction and legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.   |
|                                | .2 | Remove: Planned deconstruction and disassembly of mechanical items from existing construction including removal of all accessories supporting system or equipment taking care not to damage adjacent assemblies designated to remain; legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.   |
|                                | .3 | Remove and Salvage: Detach items from existing construction and deliver them to Owner ready for reuse.   |
|                                | .4 | Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.   |
|                                | .5 | Existing to Remain: Existing items of construction that are not removed and that are not otherwise indicated as being removed and salvaged, or removed and reinstalled.  |
|                                | .6 | Hazardous Substances: Dangerous substances, dangerous goods, hazardous commodities and hazardous products may include asbestos, mercury and lead, PCB's, poisons, corrosive agents, flammable substances, radioactive substances, or other material that can endanger human health or wellbeing or environment if handled improperly as defined by Federal Hazardous Products Act including latest amendments. |

1.5 Site  
Conditions

- .1 Existing Conditions: Condition of materials identified as being salvaged or demolished are based on their observed condition at time of site examination before tendering.
- .2 Existing Hazardous Substances: Owner has performed a hazardous substances assessment and identified materials requiring abatement as follows:
  - .1 Hazardous substances are as defined in Hazardous Products Act.
  - .2 Hazardous substances will be removed by Contractor as a part of Contract before starting Work in accordance with front end Sections 00 and 01 as they apply to the work of this discipline.
  - .3 Refer to Owner's Designated Substance Reports included as part of specifications for additional details.

PART 2 - PRODUCTS

2.1 Repair  
Materials

- .1 General Patching and Repair Materials: Refer to General Trade Sections for listing of patching and repair materials incidental to removal or demolition of components associated with work of this Section.
- .2 Mechanical Repair Materials: Use only new materials, CSA or ULC labelled as appropriate and matching components remaining after work associated with components identified for removal or demolition are completed.

2.2 Salvage and  
Debris Materials

- .1 Material Ownership: Demolished materials become Contractor's property and will be removed from Project site; except for items indicated as being reused, salvaged, reinstalled, or otherwise indicated to remain.
- .2 Salvaged Materials: Carefully remove materials designated for salvage and store in a manner to prevent damage or devaluation of materials in accordance with Section 02.

### PART 3 - EXECUTION

#### 3.1 Examination

- .1 Verification of Existing Conditions: Visit site, thoroughly examine and become familiar with conditions that may affect work of this Section before tendering Bid; Owner will not consider claims for extras for work or materials necessary for proper execution and completion of contract that could have been determined by a site visit.

#### 3.2 Scope of Of Work

- .1 The intent of the demolition scope is to remove the mechanical systems identified on the drawings in their entirety unless noted otherwise. Full extent of demolition is not illustrated on drawings. Systems and equipment are to be demolished. This contractor is responsible for breaking down all material and equipment into pieces as required to remove from site. All materials to be removed from site shall be disposed of in accordance with all Provincial codes and regulations. Consultant shall be notified if contractor is unsure of services to be removed or capped.
- .2 The Contractor is responsible for immediate reconnection of any services which are to remain and which have been disconnected during the course of demolition or construction.
- .3 Where existing materials are identified to be removed and reused, the Contractor is responsible for their removal, storage, cleaning to the satisfaction of the Consultant and reinstallation.
- .4 The Contractor shall be responsible for protecting all equipment and services to remain during the course of demolition. Should any damage occur, it shall be the Contractors responsibility to supply and install new services and equipment.
- .5 Maintain adequate structural support for services and equipment to remain during the course of demolition.
- .6 Visit site, thoroughly examine and become familiar with conditions that may affect the work of this Section before tendering the Bid; Claims for extras for work or materials necessary for proper execution and completion of the contract that could have been determined by a site visit will not be considered.

- .7 Protect systems and components indicated to remain in place during selective demolition operations and as follows:
  - .1 Notify Consultant and cease operations where safety of buildings being demolished, adjacent structures or services appears to be endangered and await additional instructions before resuming demolition work specified in this Section.
  - .2 Prevent debris from blocking drainage inlets.
  - .3 Protect mechanical systems that must remain in operation.
- .8 Maintain adequate structural support for equipment and material during demolition process.

END OF SECTION

## PART 1 - GENERAL

- |                                |    |   |
|--------------------------------|----|---|
| <u>1.1 General</u>             | .1 | Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline. |
|                                |    |   |
| <u>1.2 Reference Standards</u> | .1 | Perform the work in accordance with Ontario Building Code and local authorities having jurisdiction.    |

## PART 2 - PRODUCTS

- |  |    |   |
|--|----|---|
| <u>2.1 Soil, Storm, Waste and Vent Pipe and Fittings</u> | .1 | Piping: <ul style="list-style-type: none"><li>.1 Below Grade:<br/>Sanitary drainage, Condensate, Storm drainage, and Vent lines inside building: Cast Iron or PVC, unless otherwise noted, from Canadian and US manufacturers only.</li><li>.2 Above Grade:<br/>Shall be DWV copper or cast iron, unless otherwise noted, from Canadian and US manufacturers only.</li></ul>  |
|  | .2 | Fittings: <ul style="list-style-type: none"><li>.1 Fittings for buried cast iron pipe: cast iron.</li><li>.2 Fittings for above ground cast iron: cast iron, to CSA B70-M1978, and with factory applied corrosion resistant coating inside and out approved by Consultant.</li><li>.3 Fittings for copper drainage tube: recessed solder joints, drainage pattern fittings of wrought copper or cast brass, with 50-50 solder (lead - tin alloy).</li></ul>   |
|  | .3 | Joints: <ul style="list-style-type: none"><li>.1 Cast iron hub and spigot pipe joints: packed with oakum and tightly caulked with cast lead to CSA B67-1972.</li><li>.2 Cast iron MJ pipe joints: neoprene rubber gasket with stainless steel cover and rings, equal to Fernco.</li><li>.3 DWV copper pipe joints: solder joint.</li><li>.4 Threaded pipe joints: make with teflon tape or pulverized lead paste. Apply to male threads only.</li><li>.5 Copper to cast iron joints: male brass adaptors to tapped fitting or caulk ferrule to hub fitting, or MJ pipe joint.</li></ul> |

- .4 Fire Stopping: Submit shop drawings of fire stopping system proposal prior to construction. Refer to Section 20 00 10 for details.

## 2.2 Wall/Floor Penetrations

- .1 All pipes penetrating below grades, wall or floor slabs shall use Link-Seal modular seals.
- .2 Provide a Schedule 40 steel sleeve with welded puddle flange cast in the wall or floor, sized to suit the pipe penetration and install appropriate Link-Seal modular seal between the pipe and sleeve.

## 2.3 Natural Gas System

- .1 Provide piping to ASTM A53 Schedule 40 with approved shut-off valves, pressure regulators, reducing valves, isolation cocks, drip dirt pocket connections, pressure relief device, hardware and supports.
- .2 Connect to fuel handling systems in accordance with pertinent installation code, CAN/CGA B149.1-15 (Natural Gas and Propane Installation Code) and governing Provincial regulations under Provincial Energy Acts, using licensed trades holding current certificates of competency. Electrical work in accordance to the electrical specifications.
- .3 See drawings for gas piping layout, gas loads, gas pressure and meter locations.
- .4 The contractor shall contact the natural gas company at the start of the project and coordinate with the gas company for scheduling of the modification to the existing connection, complete and submit forms, pay all applicable fees, and apply for permit as required.
- .5 Pressure downstream of gas company regulator shall be 13.8 kPa (2 psi.).
- .6 Shut-off Valves:
  - .1 Shut-off valves shall be supplied for all appliances and where shown on drawings, and must be approved CGA.
  - .2 Except where otherwise shown, gas valves shall be lubricated plug type with cast iron body, 100% pipe area, 150 psi SWP. Provide a single lever for each valve of 75 mm or larger. Acceptable Material:



DeZurik Fig.435, Homestead Fig.601, Rockwell Fig.141, Newman-Milliken 170M/200M.

- .3 Shutoff valves for indoor appliances up to 50 mm shall be bronze ball valves rated to CGA 3.16, where approved by the local gas code/authority.

Acceptable Materials:

Crane 9302, Kitz 68, Toyo 5044A, Newman Hattersby.

.7 Pressure Reducing Valves:

- .1 Up to 5000 CFH (at 2 psi inlet) shall be a self contained pressure regulator, ULC approved, with built in relief valve. Provide a separate relief device downstream of the pressure regulator per local authority requirements suitable for the connected equipment. Acceptable Material: Fisher Fig. HSR or CS 800, Rockwell, Gould.

- .2 Over 5000 CFH (at 2 psi inlet) shall be pilot operated ULC approved pressure regulator with separate downstream relief device per local authority requirements suitable for the connected equipment. Acceptable Materials: Fisher Fig.298TK with Fig. 289 relief valve, Rockwell, Gould.

- .3 The relief connection on the regulator and/or pressure relief device on indoor systems shall be piped to outdoors.

.8 Testing:

- .1 Test at a minimum of 680 kPa or as required by Gas Company.
- .2 Provide a copy of the test chart for insertion into the Operating and Maintenance Manual.
- .3 Painting: Paint all gas lines whether exposed or concealed. Colour shall be yellow except where exposed on exterior walls where the colour shall match the wall colour.

## PART 3 - EXECUTION

### 3.1 Piping Installation

.1 General:

- .1 Install straight, parallel and close to walls and ceilings. Use standard fittings for direct changes.
- .2 Where pipe sizes differ from connection sizes of equipment, install reducing fittings close to equipment. Reducing bushings are not permitted.
- .3 Lay copper tubing so that it is not in contact with dissimilar metal and will not be kinked or collapsed.

- .4 Use non-corrosive lubricant or teflon tape applied to male thread.
- .5 Grooved pipe ends: cut square, seating surface clean and free from indent and score marks.
- .6 Install swing or swivel joints to connect risers from one floor outlet to next.
- .7 Install flanges or unions to permit removal of equipment without disturbing piping systems.
- .8 Clean ends of pipes or tubing and recesses of fittings to be brazed or soldered. Assemble joints without binding.
- .9 Do not fasten hangers from the metal roof deck.
- .2 Expansion and Contraction:
  - .1 Install expansion joints and compensators, flexible connections, pipe loops and off-sets as indicated.
  - .2 Support piping to prevent any stress or strain.
  - .3 Install guides for expansion joints, to manufacturer's instructions, otherwise, for minimum 3 m on each side of expansion joint for sizes 85 mm nominal, minimum 4.8 m on each side for larger pipe sizes.
- .3 Sanitary and Storm Drainage:
  - .1 Run piping to main sewers with uniform grade. Trap and vent fixtures as required.
  - .2 Where inverts are not given, pipes shall have uniform grade of 1:100 for pipe sizes of NPS 4 or larger, 1:50 for smaller sizes.
  - .3 Plug or cap pipe and fittings to keep out debris during construction.
  - .4 Jointing of pipe: compatible with type of pipe used.

### 3.2 Testing

- .1 Test piping in accordance with procedures outlined in Section 20 00 10, and as specified.
- .2 Testing: ensure that insulated piping and equipment installed in concealed spaces is tested and inspected prior to permanent concealment. Give forty-eight (48) hour notice to Consultant in writing.

- 3.3 Commissioning .1 Equipment: make tests to demonstrate capabilities and general operating characteristics of equipment, as instructed by Consultant. Modify equipment as required to achieve design performance of equipment and systems.
- 3.4 Cleanup .1 Leave systems operating with work areas clean to satisfaction of Consultant.

END OF SECTION



## PART 1 - GENERAL

- |                          |    |   |
|--------------------------|----|---|
| <u>1.1 General</u>       | .1 | Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.   |
|                          |    |   |
| <u>1.2 Shop Drawings</u> | .1 | Provide separate shop drawings for each isolated system complete with performance and product data, showing all calculations for loads, deflections, etc. |
|                          | .2 | Provide detailed drawings of all seismic control measures for equipment and piping, giving engineering calculations for all equipment restraints.         |

## PART 2 - PRODUCTS

### 2.1 Seismic Control Measures

- |    |   |
|----|---|
| .1 | General:  |
| .1 | All mechanical systems and equipment to be seismically restrained in the event of an earthquake in accordance with the Ontario Building Code for a High Importance building.  |
| .2 | Earthquake restraints are to be provided in accordance with the Ontario Building Code, NFPA, SMACNA "HVAC Duct Construction Standards" and good engineering practice.   |
| .3 | All equipment shall be suitably anchored, whether rigidly connected to the structure, or on vibration isolators, and designed for earthquake loading for the Brockville, Ontario area.  |
| .4 | Drilled or power-driven anchors and fasteners not permitted.  |
| .5 | No equipment, equipment supports or mounts to fail before failure of structure.   |
| .6 | Retain a seismic engineer licensed in the Province of Ontario to perform a review of the proposed mechanical installation. Provide detailed shop drawings showing the required seismic supports, bracings and fastenings restraint system for all equipment and systems to be provided under the scope of the project. These documents shall be sealed and signed by the seismic engineer and submitted as part of the shop drawing package prior to rough-in work commencing on-site. The mechanical contractor shall be solely responsible for the full scope of this work. Include all |

- costs of seismic design, materials, and site review in tender bid.
- .7 In the event that seismic restraints are determined not be necessary by the contractor's seismic design engineer, a signed and sealed letter confirming this conclusion shall be provided by the contractor's seismic design engineer and submitted for review.
  - .8 Seismic control measures not to interfere with integrity of firestopping.
- .2 Static Equipment:
- .1 Anchor equipment to equipment supports. Anchor equipment supports to structure.
  - .2 Suspended equipment shall be restrained using sway bracing and hanger rods. Equipment supported by vibration-isolation hangers should be detailed and installed with isolation hangers close to the structure and upward limit stops located directly below the hangers. Avoid bracing equipment to separate portions of the structure that may act differently in response to an earthquake. For example, do not connect a transverse brace to a wall and a longitudinal brace to a floor or roof at the same brace location.
- .3 Vibration isolated equipment:
- .1 Seismic control measures not to jeopardize noise and vibration isolation systems. Provide 6 to 9 mm clearance during normal operation of equipment and systems between seismic restraint and equipment.
  - .2 Incorporate seismic restraints into vibration isolation system to resist complete isolator unloading.
- .4 Piping System restraints shall be compatible with requirements for anchoring and guiding of piping systems.

### PART 3 - EXECUTION

#### 3.1 Installation

- .1 Seismic control measures to meet requirements of the OBC.
- .2 Install vibration isolation equipment in accordance with manufacturer's instructions and adjust mountings to level equipment.

- .3 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.
- .4 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers as follows:
  - .1 Up to NPS 4: first three (3) points of support. NPS 5 to NPS 8: first 4 points of support. NPS 10 and Over: first six (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.
  - .3 Deflection shall be not less than that for the equipment to which the piping is connected.
- .5 Where isolation is bolted to floor use vibration isolation rubber washers.
- .6 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.
- .7 Drilled or power-driven anchors or fasteners not permitted for use with seismic control measures.
- .8 All isolation hangers should be attached close to the slab or at maximum be twelve inches from the slab. Piping penetrations through the top floor slabs or walls in the penthouse mechanical rooms should be carefully sealed all around. Horizontal penetrations should be via a pre-fabricated metal sleeve with a compressible material between the pipe and the sleeve. Vertical penetrations should use an oversize hole in the slab with compressible material between the hole and the pipe and the pipe should be supported by a clamp resting on two steel load - distributing plating over neoprene pads.
- .9 Suspend ductwork, piping and equipment from roof joist only using Unistrut or other system. Do not support ductwork from metal roof deck.

3.2 Site Visit

- .1 Manufacturer to visit site and provide written certification that installation is in accordance with manufacturer's instructions and make adjustments and corrections in accordance with written report.
- .2 Provide Consultant with notice twenty-four (24) hours in advance of visit.
- .3 The engineer providing the certified design for seismic control of equipment/components/systems shall visit the site as required to provide a letter at the end of the construction indicating the installation is in accordance with the certified shop drawing submission and Ontario Building Code item 4.1.8.18 "Elements of Structures, Non-Structural Components and Equipment". The letter shall be stamped and signed, with the Professional Engineer's seal, licensed in the Province of Ontario.

END OF SECTION



## PART 1 - GENERAL

- |                       |    |   |
|-----------------------|----|---|
| <u>1.1 General</u>    | .1 | Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline. |
| <u>1.2 References</u> | .1 | CAN/CGSB-1.60-M89, Enamel, Interior, Gloss, Alkyd Type.   |
|                       | .2 | CAN/CGSB-24.3-92, Identification of Piping Systems.   |

## PART 2 - PRODUCTS

- |                                     |    |   |
|-------------------------------------|----|---|
| <u>2.1 Manufacturers Nameplates</u> | .1 | Provide metal nameplate on each piece of equipment, mechanically fastened complete with raised or recessed letters.   |
|                                     | .2 | Indicate size, equipment model, manufacturer's name, serial number, voltage, cycle, phase and power of motors.  |
| <u>2.2 System Nameplates</u>        | .1 | Colour: Hazardous - red letters, white background. Elsewhere - black letters, white background (except where required otherwise by applicable codes).   |
|                                     | .2 | Construction: 3 mm thick, laminated plastic matt finish, square corners, with letters accurately aligned and machine engraved into core.  |
|                                     | .3 | Sizes: Nameplates shall be appropriate size to accommodate 12 mm high lettering for equipment and 6mm high lettering for controllers and panels.  |
| <u>2.3 Existing System</u>          | .1 | Where work is carried out in an existing building, identify new work in accordance with the standards in place in the building, unless instructed in writing to deviate from these standards. |
| <u>2.4 Piping</u>                   | .1 | General: System shall be to CAN/CGSB-24.3. Identify the fluid medium by lettering, the classification of the fluid by the primary and secondary colours, and the direction of flow by arrows. |

- .2 Letter sizing shall be as follows:

Pipe/insulation OD (mm)	Letter Size (mm)
30	13
50	19
150	32
250	63
Over 250	88

- .3 Primary colour bands shall be 500 mm long at valves and fittings, and 1000 mm long elsewhere. Secondary colour bands shall be 50 mm wide located 75 mm in from the end of primary colour band.

- .4 Arrows shall be 150 mm long x 50 mm high where the pipe/insulation outside diameter is 75 mm and greater, and shall be 100 mm long x 35 mm high otherwise. Use double headed arrows where flow is reversible.

- .5 Material: Paints shall be to CAN/CGSB-1.60. Legend markers, arrows and colour bands shall be pressure sensitive plastic coated cloth or vinyl material with protective overcoating and waterproof contact adhesive undercoating, suitable for 100% RH and continuous operating temperature of 150°C and intermittent temperature of 200°C. Apply to dry clean prepared surfaces. Wrap tape around pipe or pipe covering with ends overlapping one pipe diameter. For pipes smaller than 20 mm, use waterproof and heat resistant pressure sensitive plastic marker tags.

- .6 Arrows and lettering shall be black or white to contrast with the primary colour band, except for fire protection piping - see later.

- .7 Pipe and valve identification:

Pipe Marker Legend	Valve Tag Legend	Primary Colour	Secondary Colour
Hot water heating supply	H.W.H.S.	Yellow	Black
Hot water heating return	H.W.H.R.	Yellow	Black
Refrigerant suction (include refig. no.)	REF.S.(No.)	Yellow	Black
Vent (plumbing)	V.P.	Green	None

- .8 Natural gas piping shall be painted entirely in yellow paint, unless specifically stated otherwise.

- .9 Controls wiring and products shall be identified in accordance with the controls section.

2.5 Ductwork

- .1 50 mm high black stencilled letters indicating type of air system (Supply Air AHU-1, exhaust fan EF-1, etc.) and directional flow arrows 150 mm long x 50 mm high.

2.6 Controls  
Identification

- .1 Identify all systems, equipment, components, controls and sensors.
- .2 The inscription shall identify function and, where applicable, the fail-safe position.

PART 3 - EXECUTION

3.1 General

- .1 Carry out identification work in accordance with CGSB-24.3 except where specified otherwise.
- .2 Provide ULC and/or CSA registration plates, as required by respective agency.

3.2 Location of  
Nameplates

- .1 In conspicuous location to facilitate easy reading from operating floor and to properly identify equipment and/or system. Provide stand-offs for nameplates on hot surfaces and insulated surfaces.
- .2 Do not insulate or paint over name plates.

3.3 Piping  
Identification

- .1 Locate on long straight runs in open areas in boiler rooms and equipment rooms, so that at least one is clearly visible from any one viewpoint in operating areas or walking aisles and not at more than 17 metre intervals.
- .2 Locate adjacent to all changes in direction; at least once in each small room through which piping passes; on both sides of visual obstruction or where run is difficult to follow; on both sides of any separation such as walls, floors and partitions; where piping is concealed in pipe chase, ceiling space, or other confined space, at entry and leaving points and adjacent to each access opening; at beginning and end points of each run and at each piece of

equipment in run; at point immediately upstream of major manually operated or automatically controlled valves - where this is not possible, place identification as close to valve as possible, preferably on upstream side.

- .3 Legend to be easily and accurately readable from usual operating areas and all readily accessible points. Plane of legend to be approximately at right angles to most convenient line of sight with consideration of operating positions, lighting conditions, reduced visibility of colour or legends caused by dust and dirt and risk of physical damage.

#### 3.4 Ductwork Identification

- .1 Stencil over the final finish only.
- .2 Locate on long straight runs in open areas in boiler rooms, equipment rooms, galleries, and tunnel so that at least one is clearly visible from any one viewpoint in operating areas or walking aisles and not at more than 17 metre intervals.
- .3 Locate adjacent to all changes in direction; at least once in each small room through which ductwork passes; on both sides of visual obstruction or where run is difficult to follow; and on both sides of any separation such as walls, floors and partitions.
- .4 Where ductwork is concealed in duct chase, gallery or other confined space, locate at entry and leaving points and adjacent to each access opening.
- .5 Locate at beginning and end points of each run and at each piece of equipment in run; at each access door; and at point immediately upstream of major manually operated or automatically controlled dampers. Where this is not possible, place identification as close to damper as possible, preferably on upstream side.
- .6 Legend to be easily and accurately readable from usual operating areas and all readily accessible points. The plane of the legend to be approximately at right angle to most convenient line of sight with consideration of operating positions, lighting conditions, reduced visibility of colour or legends caused by dust and dirt and risk of physical damage.

END OF SECTION

PART 1 -GENERAL

1.1 General

- .1 Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.

1.2 Reference Standards

- .1 Fire Resistance:
  - .1 Meet NFPA 90A and 90B. Maximum flame spread rating of twenty-five (25) and maximum smoke developed rating of fifty (50) in accordance with NFPA 255 and CAN4-S102.
  - .2 Materials tested in accordance with ASTM C411-82 shall not flame, smoulder, glow or smoke at temperature to which exposed in service.
- .2 Pipe and duct insulation to be in accordance with ASHRAE/IES Standard 90.1 Latest Edition.

1.3 Samples Submittals

- .1 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 12 mm plywood board. Affix typewritten label beneath sample indicating service.

1.4 Definitions

- .1 "Concealed" - insulated mechanical services and equipment in chases, furred spaces, pipe shafts or hung ceilings. Services in tunnels will not be considered to be concealed.
- .2 "Exposed" - will mean "not concealed" as defined herein.

1.5 Acceptable Insulation Contractors

- .1 The following is an approved list of acceptable contractors for thermal insulation work:
  - .1 Thermec Insulation Services Ltd.
  - .2 Alpine Insulation Ltd.
  - .3 B.L. Thermal Insulation Inc.
  - .4 St.Lawrence Insulation Co Ltd.

## PART 2 - PRODUCTS

### 2.1 Application

- .1 Heating water supply and return piping shall be insulated with system P-1 (or P-3 up to 104 deg C) of thickness as follows:
  - .1 Up to 32mm diameter pipe: 40mm
  - .2 Over 32mm diameter pipe: 50mm
  - .3 Insulation thickness on piping up to 32mm diameter may be reduced to 25 mm where installed in partitions.
- .2 Condensate piping/sanitary drain piping from air conditioning units, air handling units, and condensate pumps (including discharge of pump to termination point) shall be insulated with system P-2 or P-3 of thickness as follows:
  - .1 Up to 40 mm diameter pipe: 12 mm
  - .2 Over 40 mm diameter pipe: 25 mm
- .3 For air conditioning systems, insulate all supply air ducting as follow:
  - .1 Provide insulation on all new ductwork from new air-conditioning system up to the connection point into the existing ductwork distribution.
  - .2 Provide insulation of all new ductwork within ceiling space from new air-conditioning system up to the ceiling diffusers.
  - .3 Exposed supply air ductwork below the ceiling is not to be insulated, unless noted otherwise on the drawings.

Insulation shall be 25 mm system D-1 where concealed and D-2 where exposed. The insulation shall be continuous over the full length of the ductwork, and cover all duct mounted equipment and devices, such as heating coils and silencers.
- .4 For heating and ventilating systems, insulate only those portions of the supply and return ductwork running through unheated spaces with 50 mm system D-1 where concealed, and D-2 where exposed.
- .5 Insulate all unconditioned outdoor air ducts and plenums with 50 mm system D-2 or D-3.
- .6 Insulate exhaust ducts and plenums starting 2 m upstream exterior wall louvre or roof opening. Insulation shall be 50 mm system D-1 where concealed and D-2 where exposed.

- .7 Outdoor air intake and exhaust ductwork from classroom ventilator to exterior wall louver shall be insulated with 50 mm system D-1 where concealed and D-2 where exposed.
- .8 Heating or cooling ducting located outside shall be insulated with 100 mm system D-2 with an aluminum weatherproof jacket.
- .9 For ducts with acoustic insulation, the thermal insulation thickness may be reduced by 25 mm for every 25 mm of acoustic insulation.
- .10 All exposed insulated ducts shall be covered in a canvas jacket.
- .11 All exposed insulated pipework shall be covered in a canvas jacket unless noted otherwise. Pipes in mechanical rooms, service rooms and parking garages shall be covered in a PVC jacket. Pipes on roof or other outdoor installations shall be covered in an embossed aluminum jacket.

## 2.2 System P-1

- .1 Insulation shall be of fibreglass one-piece pipe insulation to CGSB 51-GP-9M with an 'all service' jacket. Butt joint strips of same material as jacket shall be furnished. Jacket seams and butt joint shall have 50 mm overlaps. When required insulation thickness exceeds that available in a single layer, manufacturer shall furnish insulation in multiple layer construction.
- .2 Insulation shall be suitable for operating temperatures of 4°C to 454°C, water vapour permeance 0.02 perms maximum, thermal conductivity k of 0.26 maximum at 38°C mean temperature.
- .3 Apply pipe insulation with joints and seams tightly butted together, using either the self sealing flaps or an approved tape and adhesive system. Bond laps by applying uniform pressure to assure complete and uniform contact.
- .4 Insulate fittings for piping with fibreglass preformed fittings or mitred segments, wired in place, to the same thickness as adjacent insulation. Apply skim coat of insulating cement to provide a smooth surface. Finish with glass fabric embedded in mastic. Alternatively, PVC approved moulded fitting covers may be used.

## 2.3 System P-2

- .1 Shall be as for System P-1 except in addition it shall include a continuous integral approved vapour barrier to CGSB 51-GP-52M.

Provide crush resistant manufactured insulated clamps equal to Cush-A-Therm to support piping without penetrating the vapour barrier. Insulated clamp shall be sealed to the adjacent insulation system to maintain the continuity of the vapour barrier.

- .2 Fittings, valves, flanges, etc. shall be insulated with mitred segments or preformed fibreglass insulation, fittings shall be wired in place. The vapour barrier shall consist of .025 mm aluminum foil wrapped tightly over insulation, with all laps sealed with vapour seal mastic into which glass fabric is embedded. A final 3.2 mm wet coat of vapour seal mastic shall then be applied. The entire vapour barrier at each flange, valve and fitting shall extend a minimum of 51 mm on to adjacent pipe insulation.

#### 2.4 System D-1

- .1 Shall be fibreglass blanket complete with vapour barrier to CGSB 51-GP-11M and CGSB 51-GP-52M.
- .2 Adhere to duct surface with mechanical fasteners approved at the rate of one per 0.14 sq.m. Butt all edges of insulation and seal all joints with 50 mm foil tape. Seal all breaks with foil tape.
- .3 On round ducts use 2.0 mm galvanized tie wires on 450 mm centres.

#### 2.5 System D-2

- .1 Shall be rigid mineral fibre board for ducting to CGSB 51-GP-10M with vapour barrier jacket and facing material to CGSB 51-GP-52M.
- .2 For round ductwork shall be semi-rigid fiberglass blanket bonded to a flexible facing with vapour barrier jacket and facing material to CGSB 51-GP-52M, density 40 kg/cu.m, equal to Johns Manville Micro-Flex.
- .3 Insulation shall be cut to fit between standing seams and stiffeners and shall be secured to ductwork by impaling over mechanical fasteners at the rate of one per 0.2 sq.m. All joints to be tightly butted. Tape all joints and cover all pin penetrations with 100 mm foil tape to provide a complete vapour barrier envelope.
- .4 Protect all edges and around access door and main door openings with 0.4 mm aluminum 50 mm x 50 mm corner beads.



### 2.6 Fastenings

- .1 Tape: self adhesive scrim reinforced foil, 100 mm wide rated under twenty-five (25) for flame spread and under fifty (50) for smoke development.
- .2 Lap Seal Adhesive, quick setting adhesive for joints and lap sealing of vapour barriers. Flame spread ten (10) smoke development 0.
- .3 Contact Adhesive: quick-setting adhesive for seams and joints of flexible unicellular insulation. Flame spread twenty-five (25), smoke development fifty (50).
- .4 Lagging Adhesive: fire retardant coating approved by authorities having jurisdiction prior to application. Consultant and the authority having jurisdiction reserves right to remove sample of covering for testing.

### 2.7 Jackets

- .1 Canvas shall be compact, firm, ULC labelled, 25/50 rated heavy plain weave cotton fabric, with flame spread less than twenty-five (25), smoke developed less than fifty (50), as supplied by S. Fattal Canvas Inc., or approved equal. Plaster dip shall be a mold inhibiting type.
- .2 For outdoor ductwork and piping, provide 6 mm thick rubberized Bitumen foil faced adhesive membrane applied only in applications where the exterior temperature is suitable to satisfy manufacturer's installation instructions: Acceptable Material shall be Polyguard Alumaguard when applied at outdoor air temperatures above 10 deg F, or 3M VentureClad 1577CW when applied at outdoor air temperatures above -10 deg F.
- .3 PVC shall be white or coloured meeting the twenty-five (25) flame spread, fifty (50) smoke developed ratings with premolded fitting covers. Acceptable material shall be Manville Zeston 2000 or Proto PVC. Install in accordance with manufacturers installations.

## PART 3 - EXECUTION

### 3.1 Application

- .1 Apply insulation after required tests have been completed and approved by Consultant. Insulation and surfaces shall be clean and dry when installed and during application of any finish in accordance with the manufacturer's recommendations.

- .2 Work shall be performed by an insulation journeyperson and a ratio of supervised registered apprentices in accordance with Skilled Trades Ontario.
- .3 Apply insulation and coverings on hot piping and equipment while surface is between 50 - 60°C.
- .4 Vapour barriers and insulation to be complete over full length of pipe, duct or surface, without penetration for hangers, standing duct seams, and without interruption at sleeves, pipe and pipe fittings.
- .5 Install insulation with smooth and even surfaces.
- .6 Apply insulation materials, accessories and finishes to manufacturer's recommendations.
- .7 Apply 0.4 mm thick aluminum corners to all ductwork in mechanical rooms or other exposed areas.
- .8 Apply 0.4 mm thick aluminum edging around access doors, access panels, or any unprotected canvas edge.
- .9 Use factory fabricated, easily disassembled insulation, for valves, fittings and process equipment requiring periodic maintenance of parts and sub-assemblies listed or indicated.
- .10 Terminate insulation at each end of unions and flanges on hot lines, and at other points where indicated, with insulation cement, to CGSB 51-GP-6M, trowelled on bevel.
- .11 Gouge out insulation for proper fit where there is interference between weld bead and insulation. Bevel away from studs and nut to permit their removal without damage to insulation, and closely and neatly trim around extending parts of pipe saddles, supports, hangers and clamp guides and seal with insulating cement.
- .12 Insulation is not required for:
  - .1 Exposed radiation and radiation runout piping located at floor level, less than 1/2 m above floor.

END OF SECTION

## PART 1 - GENERAL

- 1.1 General .1 Conform with requirements of front end Sections 00 and 01 as they apply to the work of this discipline.
- 1.2 Reference Standards .1 Do HVAC water treatment in accordance with ASME Boiler Code Section VII, and requirements and standards of regulating authorities, except where specified otherwise.  
.2 Do piping system work in accordance with ANSI B31.9-2011.

## PART 2 - PRODUCTS

- 2.1 Automatic Air Vent .1 Standard float vent with brass body and NPS 1/8 connection and rated at 690 kPa working pressure for piping of NPS 2-1/2 and smaller, Maid-O-Mist No.7, Watts FV-4M1 or equal.  
.2 For NPS 3 and larger and for high pressure applications, high capacity float vent with cast iron body to ASTM A126 Class B, stainless steel float, 20 mm connection, rated 2MPa, 232°C Sarco 13 WH, Watts FV-4M1 or equal.
- 2.2 Pipe Line Strainer .1 NPS 1/2 - 2: Bronze body, screwed connections, rated 860kPa.  
.2 NPS 2-1/2 - 12: cast iron body, flanged or grooved end connections, with NPS 1 blowdown connection, rating 860kPa.  
.3 Screen: stainless steel with perforated size of .097" using 200 x 200 mesh.  
.4 Acceptable Materials: Sarco, A. S. Leitch, Combraco, Muller, Nexus.
- 2.3 Air Purgers .1 All closed systems shall have at least one line sized air purger rated 150 psig with flanged ends. Where grooved couplings systems are acceptable, grooved ends may be supplied.  
.2 The purger shall be fitted with an air vent at the top.

2.4 Steel Pipe  
and Fittings

- .1 Pipe:
  - .1 Up to NPS 2 shall be schedule 40 black steel to ASTM A53 with threaded joints.
  - .2 NPS 2-1/2 to NPS 6 shall be schedule 40 black steel to ASTM A53 with welded joints.
  - .3 NPS 8 and over shall be schedule 30 black steel to ASTM A53 with welded joints.
  - .4 Ring groove or cut pipe joints with gasketted mechanical couplings (i.e. Victaulic) are not acceptable.
- .2 Fittings:
  - .1 Shall be Class 125/150 for water system pressures up to 175psig, or steam pressures to 125/150psig, and shall be Class 250/300 for water system pressures over 175psig and up to 300psig, or steam pressures over 125/150 psig.
  - .2 Up to NPS 2 shall be malleable iron threaded fittings Class 150 or 300 to ANSI B16.3.
  - .3 Over NPS 2 shall be cast iron fittings Class 125/250 to ANSI B16.1 or malleable iron flanged fittings Class 150/300 to ASTM B16.5, with hex head nuts and bolts to ASTM A307 and 1.6 mm thick plain or cloth inserted red rubber gaskets to ANSI B16.20 and B16.2. Alternatively, fittings may be welded using fittings to ANSI B16.9a.
  - .4 Elbows and tees shall be long radius type for NPS 2½ and larger.
  - .5 Ring grooved joints are acceptable for equipment connections, even where ring grooved pipe joints are not acceptable for the piping in the system.
- .3 Fire Stopping: Submit shop drawings for fire stopping system proposed. Refer to Section 20 00 10 for details.

2.5 Valves -  
General

- .1 All valves shall be industrial quality, manufactured to the specifications indicated. Wherever possible, valves shall be by one manufacturer.
- .2 Shut off valves up to NPS 2 for uninsulated systems only may be either ball valves or gate valves unless shown otherwise.

- .3 Shut off valves over NPS 2 for uninsulated systems only, may be butterfly valves or gate valves, unless shown otherwise.
- .4 Shut off valves on insulated systems must be gate valves for all sizes.

#### 2.6 Gate Valves

- .1 NPS 2 and under shall be screwed bronze body, union bonnet solid wedge disc, rising stem, Class 125, 860Kpa to MSS-SP-80. Acceptable Materials: Jenkins 810, Crane 428 Series, Toyo 293, Nibco T-111, Kitz 24.
- .2 Over NPS 2 shall be cast iron body, OS&Y rising stem, bronze trim, Class 125, 860Kpa FF flanges, to MSS-SP-70. Acceptable Materials: Jenkins 454J, Crane 465-1/2, Toyo 421A, Nibco F-617-0, Kitz 72.

#### 2.7 Ball Valves

- .1 For use up to NPS 2 shall be 2 piece rated 600 WOG of bronze or brass body, screwed or soldered ends, TFE seat, plated bronze/brass chrome plated solid ball and shaft. Provide extended stem on ball valves serving insulated piping systems. Acceptable Materials: Watts B6000, Toyo 5044A, Nibco T-580-70, Kitz 58/59, Milwaukee BA150, MAS B3/B4, Apollo 70-100/70-200, Nexus equal.

#### 2.8 Globe Valves

- .1 NPS 2 and under shall be screwed bronze body, renewable disc, Class 125, 860mPa, with lockshield handles where indicated, to MSS-SP-80. Acceptable Materials: Jenkins 106B, Crane 5, Toyo 220, Nibco T-235-Y, Kitz 03, Milwaukee 502.
- .2 Over NPS 2 shall be cast iron body, OS&Y bolted bonnet, bronze disc and seat ring, Class 125, 860 kPa, to MSS-SP-85. Acceptable Materials: Jenkins 2342J, Crane 351, Toyo 400A, Nibco F-718-B, Kitz 76, Milwaukee F2981M.

#### 2.9 Butterfly Valves

- .1 NPS 2-1/2 and over shall be lug style with coated ductile iron body, threaded for retaining bolts in both flanges to withstand 690kPa with downstream flange removed with zero leakage. Extended neck for pipe insulation, stainless steel stem without gland, coated ductile iron or bronze disc, EPDM resilient seat rated to 200 WOG.

Actuator to be 10 position lever lock type to NPS 6, and enclosed gear operators for NPS 8 and over. To MSS-SP-67.

- .2 Acceptable Materials: DeZurik Fig.632L, Keystone 222, Nibco 3010, Watts BF Series, Kitz#6122EL, Toyo#918besl, MAS D-Series Milwaukee CI223E, CL323E, Jenkins 2233 ELJ, Crane 44-BXZ-L/G, Apollo 143, Mueller, PSS Series 1/2. Nexus equal.

#### 2.10 Circuit Balancing Valves

- .1 Balancing valve size shall be selected by the manufacturer for a minimum pressure drop of 1.5 psi and maximum pressure drop of 4 psi in the fully open position at rated flow. Valves are not necessarily line size. Manufacturer to submit balancing valve schedule for approval.
- .2 NPS 1/2 to NPS 2 shall be of multiple turn Y pattern globe style design and all metal parts of bronze copper alloy, 250 psi rating, threaded ends, installed in any direction without affecting flow measurement and shall provide precise flow measurement, precision flow balancing, positive shut-off with no-drip seat and teflon disc, and memory stop. Shall be equal to Armstrong CBV-T, Tour and Anderson, RWV 9517 (M.A. Stewart).
- .3 NPS 2-1/2 to NPS 12 shall be of multiple turn Y pattern globe style design, all moveable internal parts of bronze copper alloy, 250 psi cast iron flanged body, and provide precise flow measurement, precision flow balancing, positive shut-off with no-drip seat and teflon disc, and memory stop. Shall be equal to Armstrong CBV-G, RWV 9574P (M.A. Stewart).
- .4 For radiation balancing valves where installed inside enclosures, valves may be single turn globe style design with sweat ends, memory stop, and metering ports on top of valve, equal to Armstrong CBV-MS, RWV 9519 (M.A. Stewart).
- .5 Acceptable Manufacturers: Armstrong, Tour and Anderson, Amtrol, RWV (M. A. Stewart), Nexus.

#### 2.6 Glycol

- .1 Where existing glycol systems are modified, supply as required premixed 50% concentration inhibited ethylene glycol solution specially designed for HVAC use, equivalent to Dow Chemicals SR-1 or Union Carbide UCartherm. Automotive antifreezes are unacceptable.

- .2 The solution shall be premixed with distilled water, before delivery to site.
- .3 The chemical treatment supplier shall verify the concentration and level of inhibitors in the completed system, adjust concentration or inhibition as required, and provide written confirmation to the Consultant.
- .4 Prior to adding any new glycol solution, perform test to confirm glycol type and concentration within existing system, and adjust new solution to match the existing.

### PART 3 - EXECUTION

#### 3.1 Installation

- .1 Ensure adequate clearances to permit performance of servicing and maintenance of equipment.
- .2 Pipe blow-off connections to nearest drain.

#### 3.2 Cleaning of System

- .1 Provide a copy of recommended cleaning procedures and chemicals for approval by Consultant.
- .2 Thoroughly flush heating water lines 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.
- .3 During circulation of cleaning solution, periodically examine and clean filters and screens and monitor changes in pressure drop across equipment.
- .4 Drain and flush systems until total alkalinity of rinse water is equal to that of make-up water. Refill with clean water treated to prevent scale and corrosion during system operation.

### 3.3 Piping

- .1 Install according to piping layout and connect to equipment in accordance drawings and with manufacturer's instructions unless otherwise indicated. Pipe drains and blow off connections to nearest drain. Ream pipes, clean scale and dirt, inside and outside, before and after assembly.
- .2 Route piping in orderly manner and maintain proper grades. 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.
- .3 Slope piping up in direction of flow. Reducers at pipe size changes shall be concentric for malleable iron fittings. All other reducer fittings at pipe size changes shall be eccentric to provide positive drainage or positive venting.
- .4 Maintain proper clearance around equipment to permit performance of service maintenance, for installation of insulation, and access to valves, fittings and other equipment.
- .5 Should deviations beyond allowable clearances arise, request and follow Consultant's directive.
- .6 Cap open ends during construction to prevent entry of foreign material.
- .7 On NPS 200 and larger mains, saddle type branch connections or directly connecting branch lines to mains will be permitted if branch line is two sizes smaller than main.
- .8 Check that all openings for appurtenances and equipment operating weight conform to shop drawings.
- .9 Make connection to equipment with unions or flanges. Install piping to minimize pipe dismantling for equipment removal. Install 3/4" diameter valved drain connections at the base of all risers, vertical pipe runs, coils, heat exchangers, and any other equipment and piping systems to provide full draindown. Drain connections to be installed 48" AFF wherever possible.



- |                                   |    |   |
|-----------------------------------|----|---|
| <u>3.4 Strainers</u>              | .1 | Install in horizontal or down flow lines. Ensure clearance for removal of basket.   |
|                                   |    |   |
| <u>3.5 Air Vents</u>              | .1 | Install at high points of systems. Pipe over-flow to nearest drain. On large capacity air vent, install gate valve upstream of air vent.  |
|                                   |    |   |
| <u>3.6 Valves</u>                 | .1 | Install valves with stems upright or horizontal unless approved otherwise.  |
|                                   | .2 | Install chain operators on valves over three (3) metres above floor.  |
|                                   | .3 | Install gate valves at all branch take-offs to isolate each piece of equipment, and as indicated.   |
|                                   | .4 | Install circuit balancing valves for balancing.   |
|                                   |    |   |
| <u>3.7 Pipe Testing</u>           | .1 | Test system to 1-1/2 times working pressure but not less than 860 kPa.  |
|                                   | .2 | Isolate any equipment not capable of withstanding test pressure.  |
|                                   | .3 | Maintain test pressure for 4 hours without drop in pressure.  |
|                                   | .4 | Rework any leaking joints and repeat test.  |
|                                   |    |   |
| <u>3.8 Piping and Accessories</u> | .1 | All piping and accessories, including but not limited to strainers, check valves, backflow preventers, isolation valves, flexible connections, unions, etc., shall be sized to match the pipe diameter unless otherwise indicated on the drawings and schematics. The fittings and accessories shall not match the equipment (pump, coil, A/C unit,...) pipe connection size, unless indicated otherwise. Provide transition fittings immediately at the equipment inlet and discharge connections as required. |
|                                   |    |   |
| <u>3.9 Existing Systems</u>       | .1 | Where project scope involves work on an existing hydronic system, the contractor shall be responsible for the partial or full system  |

drain down and re-fill, as required, with the same type of fluid and chemical treatment as originally present in the system.

- .2 At completion of work, as part of the system re-fill and start-up process, the contractor shall be responsible to remove all air from the new and existing equipment and piping distribution system, to re-instate the system's operation to the condition present at the start of the project. Provide air vents as required on existing and new piping.

END OF SECTION

## PART 1 - GENERAL

### 1.1 General

- .1 Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.

### 1.2 References

- .1 ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.
- .2 ANSI/ASME B16.24, Cast Copper alloy Pipe Flanges and Flanged Fittings. Classes 150, 300, 600, 900, 1500 and 3000.
- .3 ANSI/ASME B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
- .4 ANSI/ASME B31.5, Refrigeration Piping and Heat Transfer Components.
- .5 ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile.
- .6 ASTM B280, Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- .7 CSA B52, Mechanical Refrigeration Code.
- .8 EPS 1/RA/, Code of Practice for the Reduction of CFC's (Environment Canada).

## PART 2 - PRODUCT

### 2.1 Tubing

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

### 2.2 Fittings

- .1 Service: design pressure 300 PSIG and temperature 250°F.
- .2 Brazed:
  - .1 Fittings: wrought copper to ANSI/ASME B16.22.

.2 Joints: silver solder, 45% Ag-15% Cu or copper-phosphorous, 95% Cu-5%P and non-corrosive flux.

.3 Flanged:

.1 Bronze or brass, to ANSI/ASME B16.24, Class 150 and Class 300.

.2 Gaskets: suitable for service.

.3 Bolts, nuts and washers: to ASTM A307, heavy series.

.4 Flared:

.1 Bronze or brass, for refrigeration, to ANSI/ASME 16.26.

### 2.3 Pipe Sleeves

.1 Hard copper or steel, sized to provide six (6) mm clearance all around between sleeve and uninsulated pipe or between sleeve and insulation.

### 2.4 Valves

.1 22 mm and under: Class 500, 3.5 Mpa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moisture proof seal for below freezing applications, brazed connections. Ball valves meeting this same performance criteria and suitable for refrigeration systems are acceptable.

.2 Over 22 mm: Class 375, 2.5 Mpa, globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and bonnet, moisture proof seal for below freezing applications, brazed connections. Ball valves meeting this same performance criteria and suitable for refrigeration systems are acceptable.

### 2.5 Insulation

.1 Insulate all refrigeration suction lines with 9 mm thick insulation for up to NPS 2 pipe size and 20 mm thick insulation for over NPS 2 pipe size. Insulation shall be flexible elastomeric closed cell insulation to CAN/CGSB-51.40 with a flame/smoke rating not exceeding 25/50 when tested in accordance with CAN4-S102. When installed outdoors, the insulation shall be covered for UV protection as per insulation manufacturer's recommendations.

.2 Insulate refrigeration discharge lines as follows:

.1 Where hot discharge piping could prove to be a safety hazard.

- .2 When an air cooled condenser requiring head pressure control is utilized and the piping is exposed to low temperature outdoor air.
- .3 Insulate with 9 mm thick insulation for up to NPS 2 pipe size and 20 mm thick insulation for over NPS 2 pipe size. Insulation shall be flexible elastomeric closed cell insulation to CAN/CGSB-51.40 with a flame/smoke rating not exceeding 25/50 when tested in accordance with CAN4-S102. Outdoor insulation shall be UV protected as per insulation manufacturer's recommendations.

### PART 3 - EXECUTION

#### 3.1 General

- .1 Install in accordance with CSA B52, EPS 1/RA/1 and ANSI/ASME B31.5.
- .2 Connect to equipment with isolating valves. Isolation valves (ball valves) shall be installed at the condenser inlet (discharge line), condenser outlet (condensate or liquid line), receiver inlet, and receiver outlet.
- .3 Provide space for servicing, disassembly and removal of equipment and components all as recommended by manufacturer.
- .4 Protect all openings in piping against entry of foreign material, contaminants and moisture.
- .5 Refrigeration systems larger than three (3) tons (11kW) or refrigeration systems in air conditioning systems larger than five (5) tons (18kW) shall be installed in accordance with the Technical Standards and Safety Act, 2000.

#### 3.2 Brazing Procedures

- .1 Bleed inert gas into pipe during brazing.
- .2 Prior to brazing, remove valve internal parts, disassemble sight glasses and solenoid valves.
- .3 Do not apply heat near expansion valve and bulb.
- .4 Protect all components that may be damaged by being exposed to excessive heat.

### 3.3 Piping Installation

- .1 General: Soft annealed copper tubing: bend without crimping or constriction. Hard drawn copper tubing: do not bend. Minimize use of fittings.
- .2 Hot gas lines and Suction lines:
  - .1 Pitch at least  $\frac{1}{2}$  inch for each ten (10) feet of run down in the direction of flow to promote oil movement in the horizontal runs.
  - .2 Provide a trap at base of risers greater than eight (8) feet high and at each twenty-five (25) feet thereafter.
  - .3 Provide an inverted deep trap at top of each riser.
  - .4 Provide double risers for compressors having capacity modulation.
    - .1 Large riser: install traps as specified above.
    - .2 Small riser: size for a minimum of 1000 feet per minute at minimum load. Connect upstream of the trap serving the larger riser.

### 3.4 Pressure and Leak Testing

- .1 Close valves on factory charged equipment and other equipment not designed for test pressures.
- .2 Leak test to CSA B52 before evacuation to 2 MPa and 1 MPa on high and low sides respectively. 200 PSIG on both sides is adequate.
- .3 Test Procedure: Test with nitrogen to required pressure. Test for leaks with detector. Repair leaks and repeat tests.

### 3.5 Dehydration and Charging

- .1 Close service valves on factory charged equipment.
- .2 Ambient temperatures to be at least 13°C for at least 12 hours before and during dehydration.
- .3 Use copper lines of largest practical size to reduce evacuation time.
- .4 Use 2-stage vacuum pump with gas ballast on 2nd stage capable of pulling at least 100 microns and filled with dehydrated oil.

- .5 Measure system pressure with vacuum gauge. Take readings with valve between vacuum pump and system closed.
- .6 Triple evacuate all piping and system components containing refrigerant gases other than correct refrigerant charge or holding charge to achieve the following:
  - .1 A standing vacuum of 250 microns or less for a period of not less than two (2) hours, or
  - .2 A standing vacuum of 500 microns or less for a period of not less than twelve (12) hours, or
  - .3 As recommended by manufacturer, whichever is more stringent.
  - .4 Submit all test results in writing to Consultant.All tests shall be witnessed by the Consultant or the Consultants designate.
- .7 Charging:
  - .1 Charge system through filter-drier and charging valve on high side. Low side vapour charging "only" is permitted.
  - .2 With compressors off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.
  - .3 Re-purge charging line if refrigerant container is changed during charging process. No refrigerant can be purged.
- .8 Checks:
  - .1 Make all checks and measurements as per manufacturer's operation and maintenance instructions.
  - .2 Record and report all measurements in writing to the Consultant.

### 3.6 Insulation

- .1 Apply insulation after required tests have been completed and approved by the Consultant. Insulation and surfaces shall be clean and dry when installed and during application of any finish in accordance with manufacturer's recommendations.

END OF SECTION





PART 1 - GENERAL

1.1 General

- .1 Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.

1.2 Reference  
Standards

- .1 HVAC Duct Construction Standards - Metal and Flexible 1985.
- .2 SMACNA HVAC Duct Leakage Test Manual 1985.
- .3 ASHRAE Handbook, Fundamentals and Systems Volume.
- .4 CAN4-S112-M82 1987: Fire Test of Fire Damper Assemblies.
- .5 CAN/ULC S110-M86: Fire Tests for Air Ducts.
- .6 UU81-1981: Factory Made Air Ducts and Connections.
- .7 NFPA 90A-1985: Installation of Air Conditioning and Ventilating Systems.
- .8 NFPA 96: Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .9 ASHRAE 36B-63: Method of testing for rating acoustic performance of air control and terminal devices and similar equipment.
- .10 NFPA 251: Fire test of Building Construction Materials.
- .11 ARI 430: ARI Standard for Central Station Air Handling Units.
- .12 Fans
  - .1 AMCA 99-1983, Standards Handbook
  - .2 ANSI/AMCA 210-1985, Laboratory Methods of Testing Fans for Rating.
  - .3 AMCA 300-1985, Reverberant Room Method for Sound testing of Fans.
  - .4 AMCA 301-1976, 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.

1.3 Shop Drawings  
and Maintenance  
Materials

- .1 Shop drawings shall include ductwork interference drawings clearly showing co-ordination with all other trades.
- .2 Furnish list of individual manufacturer's recommended spare parts for equipment and addresses of suppliers of same, together with list of specialized tools necessary for adjusting, repairing or replacing of same, for placement into operating manual.

1.4 Manufactured  
Items

- .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 in force.

1.5 Coordination

- .1 Coordinate with all other trades to facilitate installation of lights, sprinkler heads, plumbing and sprinkler piping, etc.

PART 2 - PRODUCTS

2.1 H.V.A.C.  
Ductwork

- .1 Ductwork shall be constructed to withstand 1-1/2 times the working static pressure without mechanical failure, using galvanized lock forming quality steel with Z90 designation zinc coating to ASTM A525M-86 or G90 designation to ASTM A525.

- .2 Ductwork gauges, reinforcing and sealing techniques, shall be in accordance with latest edition of SMACNA, for the following classifications:

System	Pressure Class Pa.	Pressure Class ("wg)	Seal Class
Washroom exhaust	-250	(-1")	C
Return air	-250	(-1")	--
Rooftop and indoor unit constant volume supply	+500	(+2")	C
(Misc.) General exhaust	-250	(-1")	C

The contractor shall submit a schedule for each system showing the proposed duct construction including size, gauge, reinforcing type, and support details.

- .3 The seal classification outlined above is to comply with SMACNA, but generally as follows:

- .1 Class A: Seal all transverse joints, longitudinal seams, and duct wall penetrations.
- .2 Class B: Seal all transverse joints and longitudinal seams.
- .3 Class C: Seal all transverse joints.

The sealant shall be of water based suitable for indoor and outdoor applications.

Acceptable Materials: Duradyne, Foster, McGill Air Seal.

- .4 Tape shall be polyvinyl treated open weave fibreglass type, 50 mm wide.
- .5 All fittings shall be constructed in accordance with SMACNA or ASHRAE standards. Radiused 1-1/2D elbows shall be used wherever possible. If necessary to avoid obstructions, smaller radii may be used with single thickness vanes. Square elbows over 400 mm size shall have double thickness vanes.
- .6 Diffuser takeoffs shall be conical complete with butterfly dampers. Straight spin-ons shall not be used at any locations. Should height of duct be insufficient to accommodate a conical take-off fitting, provide rectangular side take-off fitting with 45 degree tapered entry with transition to circular duct.

- .7 For duct pressure classifications of 1000 Pa (+4") and higher, rectangular duct joints must be a proprietary system. Non proprietary systems are not acceptable.  
Acceptable Materials: Ductmate, Nexus
- .8 Spiral Wound and Flat Oval ductwork to be as follows:
  - .1 Provide factory fabricated spiral wound duct and matching fittings in accordance with current SMACNA HVAC Duct Construction Standards - Metal & Flexible, except where indicated otherwise. Provide duct materials, gauges, reinforcing and sealing for operating pressures indicated.
  - .2 Transform duct sizes gradually, not exceeding 15° divergence and 30° convergence.
  - .3 Branch connections: 45° lateral takeoffs of 90° conical fittings.
- .9 Button punch snaplock not to be used on medium or high pressure systems.

## 2.2 Duct Hangers and Supports

- .1 Rectangular ductwork in exposed or concealed areas, insulated or non-insulated, shall be supported on black rolled steel angles with black steel threaded rods.
- .2 Round ductwork up to 1270mm (50") diameter in exposed or concealed areas, insulated or non-insulated, shall be supported with galvanized steel straps with black steel threaded rods, equal to Ductmate round duct strap bracket. A galvanized steel suspension ring band with a threaded support rod is acceptable up to 300mm (12") diameter ductwork, equal to Ductmate round duct hanger. For ductwork larger than 1270mm (50") diameter, submit SMACNA support detail for review.
- .3 Flat oval ductwork up to 1270mm (50") in width in exposed areas, insulated or non-insulated, shall be supported with galvanized steel straps with black steel threaded rods, equal to Ductmate round duct strap bracket. Larger ductwork shall be supported on black rolled steel angles with black steel threaded rods. For concealed areas, supports shall be as per exposed installations or alternatively supported on black rolled steel angles with black steel threaded rods.

- .4 Steel angles shall be in accordance with the following table:

Duct Size mm	Angle Size mm	Rod Size mm	Spacing M
up to 750	25 x 25 x 3	6	3
751 to 1050	40 x 40 x 3	6	3
1051 to 1500	40 x 40 x 3	10	3
1501 to 2100	50 x 50 x 3	10	2.5
2101 to 2400	50 x 50 x 5	10	2.5
2401 and over	50 x 50 x 6	10	2.5

### 2.3 Flexible Ductwork

- .1 Shall comply with the requirements of CAN-ULC-S110, Class 1.
- .2 Unless otherwise noted, a flexible duct shall not exceed a length of three (3) meters. Flexible ducting shall not be used in exposed locations.
- .3 Duct shall be rated for 2500 Pa (10" w.g.) pressure, and be of flexible spiral wound aluminum with triple locked seams and shall be factory insulated with 25 mm thick fibreglass insulation, and approved jacket, unless ductwork is not required to be insulated.

### 2.4 Internal Acoustic Duct Lining

- .1 25 mm thick high density flexible fibrous glass duct liner fastened to interior sheet metal surfaces with 100% coverage of an approved fire resistant bonding adhesive and metal pins and washers, spaced on not more than 300 mm centres. Only long fibre products as manufactured by a flame attenuated process will be acceptable, with a black acrylic scrim lining on one face.
- .2 Seal edges, pin penetrations and joints with approved fire resistant mastic.
- .3 Protect leading edges with sheet metal edging.
- .4 Flame spread rating on interior lining shall not exceed twenty-five (25).

- .5 Materials:
  - .1 CGSB 51-GP-11M fibrous glass rigid board.
  - .2 Acceptable Materials:  
Rectangular ductwork: CertainTeed ToughGuard, Johns Manville Permacote Linacoustic RC-HP, Manson equivalent.  
Spiral and flat oval ductwork: CertainTeed ToughGuard Ultra Round, Johns Manville Spiracoustic Plus, Manson equivalent.
- .6 Duct sizes show only free area. Increase metal ducts to accommodate acoustic insulation.

#### 2.5 Duct Access Doors

- .1 Provide where indicated, and for access to all fire dampers, dampers, for cleanouts on specialty systems, and everywhere internal ductwork systems require inspection and maintenance. Access doors shall be fabricated of same material as ductwork. For insulated ducts, access doors shall be sandwich construction with 25 mm thick rigid fibreglass insulation.
- .2 Access doors on rectangular ductwork shall be flat oval shape, double flange, ultra-low leakage with a minimum of two camlock fasteners. Minimum size shall be 450 x 250 mm, unless otherwise stated or required. Acceptable Material: Nailor 0800 type M1, or equal.
- .3 Access doors on round ductwork shall be high pressure caulked and screwed to turret box, welded to saddle. Saddle shall be formed to duct radius. Door shall be held in place with a minimum of two camlock fasteners. Size shall be suitable to provide maintenance access to internal component. Acceptable Material: Nailor 0895, or equal.
- .4 Access doors on round duct branches to individual diffusers shall be low pressure design with curvature to match duct radius, with polyethylene gasket, hinge and locking brackets. Acceptable Material: Nailor 0890, or equal.

2.6 Flexible  
Connections

- .1 Provide at fans and at air handling unit duct connections, as well as where indicated, neoprene coated fire resistant self extinguishing glass fabric, minimum density 814 g/sq.m., factory fabricated, not more than 150 mm long between metal parts and installed with just sufficient slack to prevent vibration transmission. Allow 100 mm movement to low pressure fans.  
Flexible connections shall be air tight and suited for operations up to -40°to 120°C.
- .2 Acceptable Materials: Durodyne Durolon, Vent Fabrics Inc. Ventglass, Elgen Manufacturers Neoprene

2.7 Turning  
Vanes

- .1 Provide small arc air foil hollow vanes in duct elbow where centreline radius is less than 1-1/4 times turning dimension of duct.

2.8 Instrument  
Test Ports

- .1 1.6 mm thick steel zinc plated, neoprene expansion plug complete with handle, chain and cam lock handles, 28 mm minimum inside diameter and neoprene mounting gasket. For insulated ducts use extension neck. Acceptable material: Durodyne, or equal.

2.9 Balancing  
Dampers

- .1 Splitter dampers: where indicated with locking quadrant on exterior duct. Dampers to be single thickness one gauge heavier than duct.
- .2 Single blade round butterfly dampers: to be 0.8 mm thick where indicated with locking quadrants.
- .3 Multi-leaf opposed blade dampers: designed to SMACNA details with locking quadrant to be used in rectangular ducts.

2.10 Dynamic Fire  
Dampers

- .1 Fire dampers shall be listed and bear label of ULC, and shall meet requirements of NFPA 90A and authorities having jurisdiction. These dynamic dampers may be used in any system whether designed to shut down or stay operating on fire alarm.

- .2 Dampers shall be classified to UL555 for dynamic closure against 4000 feet per minute airflow at 4" w.g. differential pressure (20 m/s at 1 kPa). Dampers to be rated at not less than 1-1/2 hrs.
- .3 Mild steel, fire link actuated multi-blade (airfoil blade) hinged spring assisted operation to close and lock in closed position under airflow conditions. Curtain style dampers (such as multi sectional dampers) may be used as long as the construction quality, performance and listings noted above are achieved. Curtain style dampers are to be out of airstream, except where shown otherwise. Horizontal fire dampers shall be supplied with pull tab to facilitate resetting.
- .4 Fire damper assemblies shall be galvanized steel. Installation shall be complete with frame and 40 x 40 x 3 mm angle iron on full perimeter of frame on both sides of barrier being pierced.

#### 2.11 Fire Stop Flaps

- .1 To be ULC listed and labelled.
- .2 Construct of minimum 1.5 mm thick sheet steel with 1.6 mm thick non-asbestos ULC listed insulation and corrosion resistant pins and hinges.
- .3 Flaps to be held open with fusible link conforming to ULC-S505-1974 and close at 74°C or as indicated.
- .4 Provide thermal blankets and accessories required to maintain the integrity of the ceiling assembly in accordance to the ULC requirements.

#### 2.12 Grilles, Registers and Diffusers - General

- .1 Sizes indicated on the drawings are nominal. Provide correct standard product nearest to nominal for capacity throw, noise level, throat and outlet velocity.
- .2 Contractor shall be responsible to confirm the exact diffuser module dimension for compatibility with the existing or new suspended ceiling grid system prior to submitting shop drawings. Perform necessary measurements on site for existing ceiling installations,



and coordinate with Architectural trades and ceiling system shop drawings for new ceiling constructions.

- .3 Construction:
  - .1 Steel: prime coated stamped or cold rolled steel with exposed joints welded and ground flush and completely closed.
  - .2 Aluminum: extruded with mechanical fasteners and completely closed corners.
  - .3 Provide plaster frames as plaster stops where set into plaster or gypsum board.
  - .4 Provide concealed fasteners and operators.
  - .5 Unless stated otherwise, colour shall be off-white.
- .4 Linear diffusers shall include fully acoustically insulated plenums, even if not specifically listed in the grilles and diffuser schedules.
- .5 Acceptable Materials: E. H. Price, Krueger, Nailor Industries, Metal-aire.

#### 2.13 Cabinet Fans F-1 and F-2

- .1 Centrifugal in-line fans in factory fabricated casing complete with inverter duty motor. Fabricate casing of zinc coated steel, reinforced and braced for rigidity. Provide removable panels for access to internal parts. Cabinets shall be internally insulated.
- .2 Fans shall be supplied with factory installed variable speed drive, factory wired to the motor, to receive modulating control signal from the building automation system.
- .3 Performance as indicated on the drawings. Acceptable Material: PennBarry SQX, Delhi, Cook, Greenheck, Twin City.

#### 2.14 Ceiling Mount Exhaust Fan F-7

- .1 Shall be a centrifugal fan within an acoustically insulated cabinet, direct driven, vibration isolated motor with thermal overloads, unit mounted solid state speed controller with OFF position factory wired to fan motor, AMCA certified, CSA approved.

- .2 Acceptable material: Penn Zephyr, Greenheck, Cook, Carnes, Twin City, Broan, Jennco Fan, S&P Canada.

2.15 De-stratification  
Fans F-3 to F-6

- .1 Shall be up/downdraft airflow rotation, 120V, 1ph., 0.9 AMPS impedance protected DC type variable speed motor with permanently lubricated ball bearings. Blades shall be painted steel with curved ends. Colour shall be white or black, as directed by the Architect.
- .2 Downrod shall be 36" long.
- .3 Provide a safety cage (fan guard) protecting the sides and bottom of fan. Cage shall be removable for servicing of fan.
- .4 Wall mounted fan speed controller shall provide 5 speed adjustment, forward and reverse, designed to fit in a standard electrical box. Controller shall be capable of controlling a minimum of five (5) fans.
- .5 Fan assembly shall be secured with chain to building structure. Provide angular mounting kit for angled ceilings.
- .6 Acceptable Materials: Canarm DC Industrial Fans model CP RREM-DCQ014-W controller, or equal.

2.16 Rooftop Air  
Conditioning Units

- .1 Shall be single zone roof mounted package with DX cooling, gas heat exchanger, 50 mm Merv 13 filters, airside economizer controlled from dry bulb, with intake and exhaust air hoods. The unit shall be CSA and ULC approved, and shall be rated to ARI 210 Standard for Unitary Air Conditioning Equipment. Cooling system efficiency, and fan efficiency for motors 5 HP and larger shall comply with ASHRAE 90.1-2013 edition. Compressors and heat exchangers shall be warranted for 5 years, parts only, non prorated. Unit shall be supplied with stainless steel heat exchanger.
- .2 Down and side discharge units shall be complete with 600 mm high insulated roof curb suitable for seismic anchoring.

- .3 Units of nominal 5 ton capacity and smaller shall have economizers with barometric dampers. Units of nominal 7.5 ton capacity and larger shall have a powered exhaust rated for a minimum of 50% capacity at 0.1" pressure. Economizers shall be controlled from dual enthalpy. Power exhaust fan shall be factory installed and wired. If supplied loose, mechanical contractor shall be responsible for all associated installation, including control and power wiring.
- .4 Compressors shall be hermetic. Refer to schedule for minimum stages of cooling. Provide low ambient lockout on the second stage cooling. Condenser fans shall be permanently lubricated and have built in thermal overloads.
- .5 Supply fans for units shall be direct drive with ECM motor, forward curve centrifugal. RTU-22 shall be belt driven multi stage air volume. Units with a cooling capacity of 65,000 BTU or larger at AHRI conditions shall be supplied with a fan control system to automatically reduce the fan speed to no greater than 66% during periods of low cooling, drawing no more than 40% of the fan power at low speed.
- .6 Heating for units (3) ton or larger shall be a minimum of two stages.
- .7 Where noted in the schedule, units shall be provided with a heat recovery wheel system. System shall be either factory mounted to rooftop unit, or field installed. Field installed systems shall be provided with factory installed electrical disconnect switch. Mechanical contractor shall be responsible for all field associated installation requirements, including interconnection wiring.
- .8 Unit shall be supplied with a BACnet controller for connection to the building automation system, allowing supply scheduling, air temperature reset and general fault monitoring. Refer to the BAS sequence of operation.
- .9 Unit shall be supplied with a factory installed and wired main electrical weatherproof disconnect switch, as well as 120V/20A 5-20R weatherproof service receptacle for field wiring by electrical contractor.
- .10 Acceptable Materials: Lennox, Trane, Carrier, York, Engineered Air.

2.17 Exhaust/Intake  
Dampers

- .1 Dampers shall be constructed of 6" extruded aluminum insulated blades, 12 ga. insulated extruded aluminum frames, double sealed bearings, with side and blade seals, rated at less than 0.6% leakage at 10" s.p.
- .2 Damper shall be supplied with end switch for confirmation of open damper position.
- .3 Acceptable manufacturers: Tamco Series 9000, Ruskin CDTI-50, Alumavent 3900 Series.

2.18 Louvres

- .1 Louvres to be high performance AMCA rated, 100 mm deep, 2 mm thick extruded aluminum blade and frame construction, Type 6063-T5 alloy, entirely welded, 45 degree blades with drainable head frame, with 12 mm x 12 mm 1.6 mm aluminum birdscreen. Minimum free area shall be 50% for a 1200 x 1200 louver, with a beginning point of water penetration at 960 fpm (4.88 m/s) with 0.104" w.g. (0.026 kPa) pressure drop. Finish in baked enamel in a colour to be selected at time of shop drawing review.
- .2 Acceptable Materials: Airolite K609HP, or equivalent by Ruskin, Ventex/Alumavent, Nailor, Greenheck.

2.19 Split Air-  
Conditioning Unit

- .1 Shall be a split air-conditioning unit with indoor evaporator module and outdoor condensing unit, joined with field installed refrigerant piping. Indoor unit shall be equal to Mitsubishi PKA model exposed high-wall mounted.
- .2 Cooling only outdoor condensing unit shall contain inverter driven scroll compressor and air cooled condenser system, equal to Mitsubishi PUY model.
- .3 Refrigerant piping shall be sized and installed as per manufacturer's recommendations. Both refrigerant lines shall be insulated separately with closed cell, flexible elastomeric foam insulation. No p-traps are to be installed in the refrigerant piping.

- .4 A three-pole electrical disconnect switch shall be supplied with the indoor unit, for field installation. The outdoor unit shall require a field installed and wired electrical disconnect switch. Power supply to the system shall be to the outdoor condensing unit, and from the outdoor unit to the indoor evaporator unit.
- .5 Indoor unit shall be supplied with a condensate pump, either internal to the unit or field installed, with a minimum capacity of 3 gallons per hour, 20 feet of head, and 16 feet of suction lift. Pump shall be powered from the air-conditioning unit power supply, either factory wired or field wired by the contractor.
- .6 A 2-wire wall control shall be supplied with the system.
- .7 The unit shall be connected to the building automation system. Provide BACnet controller Coordinate with controls contractor.
- .8 Acceptable material: Mitsubishi P-Series, LG, Daikin, Fujitsu

### PART 3 - EXECUTION

#### 3.1 Duct Installation

- .1 Install steel duct in accordance with SMACNA standards.
- .2 Do not break continuity of insulation vapour barriers by hangers or rods. Insulate strap hangers 100 mm beyond insulated duct.
- .3 Install breakaway joints in ductwork on each side of fire separation.
- .4 Anchor all risers in accordance with SMACNA Standard.
- .5 Install fire dampers to NFPA 90A.
- .6 Make fresh air intake ducts watertight up to end of transition. Fit drain connections on bottom with minimum 20 mm pipe to funnel drain.
- .7 Apply sealant to outside of joint to manufacturer's recommendations. Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturer's recommendations.

- .8 Suspend ductwork and equipment from roof joist only using Unistrut or other system. Do not support ductwork from metal roof deck.

### 3.2 Fresh Air and Exhaust Openings

- .1 Install to SMACNA details.
- .2 Reinforce and brace air outlets and intakes for wind speed as per NBC for location.
- .3 Provide air inlet openings with 1.6 mm thick 25 mm and air outlet openings with 12 mm mesh screwed aluminum birdscreens.

### 3.3 Duct Leakage Testing

- .1 Supply ducts of pressure classification 750 Pa (+3") or higher for variable air volume systems, and all ductwork located outdoors, shall be tested for leakage at 1-1/4 times the ductwork design pressure class. Testing method and calculation shall follow SMACNA HVAC Duct Leakage Test Manual and ASHRAE 90.1 guidelines. Representative sections of ducts, representing a minimum of 25% of the total installed duct area, shall be pressure tested.
- .2 All supply ducts of pressure classification 500 Pa (+2") from constant volume rooftop units and indoor air handling systems shall be tested for leakage at 1-1/4 times the ductwork design pressure class. Testing method and calculation shall follow SMACNA HVAC Duct Leakage Test Manual and ASHRAE 90.1 guidelines. Representative sections of ducts, representing a minimum of 25% of the total installed duct area, shall be pressure tested.
- .3 Make trial leak test, as instructed to demonstrate workmanship.
- .4 Install no additional ductwork until trial test has been passed.

### 3.4 Flexible Ductwork Installation

- .1 Locate between supply air duct and grilles, registers and diffusers where shown.
- .2 Support flexible ducts at 1.0 metre centres.

- .3 Maximum length of flexible duct connections: 900 mm for control boxes and 3 m for supply air diffusers.
- .4 Make connections between flexible duct and terminal devices airtight with clamps and duct sealant.

### 3.5 Flexible Connection Installation

- .1 Install in following locations:
  - .1 Inlets and outlets to supply air units and fans.
  - .2 Inlets and outlets of exhaust and return air fans.
  - .3 As indicated.
- .2 Length of connection: 100 mm.
- .3 Minimum distance between metal parts when system in operation: 75 mm.
- .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.

### 3.6 Instrument Test Ports

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

### 3.7 Acoustic Duct Lining Installation

- .1 Install lining in accordance with manufacturer's recommendations.
- .2 Refer to drawings for ducts requiring acoustic duct lining shown cross hatched, or with internal dashed line.

### 3.8 Fire Damper Installation

- .1 Install fire dampers to NFPA 90A-1985 and in accordance with conditions of ULC listings. Locate in fire walls and partitions where indicated or required by Code. All fire dampers installed within supply and return ductwork connecting to air handling systems, fans, or any other forced air system shall be dynamic type fire dampers.
  - .1 Prior to installation, the contractor shall submit the manufacturer's ULC Listed installation instructions c/w the appropriate framing instructions as a shop drawing submission. Prior to installation, photos shall be submitted by the mechanical contractor indicating all framing for the fire dampers has been provided in accordance with the listed installation. Coordinate with the General Contractor with respect to the framing for the fire dampers.
  - .2 After completion, have installation approved prior to concealment.
  - .3 For fireproof ceiling assemblies, suspend unit from structure independently of ceiling system. Maintain integrity of rated ceiling assembly as per NFPA and ULC.
  - .4 Install access door adjacent to each fire damper.

### 3.9 Balancing Damper Installation

- .1 Install balancing dampers at all branch ducts and as indicated on drawings.

### 3.10 Grilles, Registers and



Diffusers  
Installation

- .1 Install in accordance with manufacturer's instructions.
- .2 Fit frame with gasket to prevent leakage, and smudging.
- .3 Install with flat head cadmium plated screws in countersunk holes where fastenings are visible.
- .4 Locations shown are approximate. Refer to reflected ceiling plans and coordinate with Division 16 for lights.

3.11 Exhaust Fans  
Installation

- .1 Install fans as specified. Complete with resilient mountings as applicable.
- .2 Install flexible connector bands between fan inlet and discharge ductwork. Ensure metal bands of connectors are parallel with minimum 75 mm flex between ductwork and fan during running.
- .3 Install fan restraining snubbers. Flexible connections shall not be in tension during running.
- .4 Provide sheaves and belts required for final air balance.

3.12 Filters

- .1 At completion of the project, after equipment start-up, balancing and commissioning procedures are completed, replace all filters within all air handling equipment with new filters, including pre-filters and final filters. Supply client one full filter replacement package for each air handling equipment and store on site where instructed by client.

END OF SECTION



## PART 1 - GENERAL

- |                          |    |  |
|--------------------------|----|--|
| <u>1.1 General</u>       | .1 | Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.  |
| <u>1.2 Standards</u>     | .1 | All units shall be CSA and/or CGA approved.  |
| <u>1.3 Shop Drawings</u> | .1 | Submit shop drawings for the complete unit clearly showing control wiring, electrical connections, pipe connections, and main construction features all in accordance with Division 1. |

## PART 2 - PRODUCTS

### 2.1 Welding Shop Direct Gas Fired MAU-3

- |    |  |
|----|--|
| .1 | <u>General</u>   |
| .1 | Direct fired make-up air heaters shall be built to the level of quality as herein specified. Units must comply with codes and authorities having jurisdiction and have CGA approval.   |
| .2 | Unit shall be shipped in one piece, factory assembled. Unit and all controls shall be factory tested for construction and operation.   |
| .3 | Acceptable Materials: Engineered Air HE Series, Temprite.  |
| .2 | <u>Unit Construction</u>   |
| .1 | Unit casing shall be of minimum 18 gauge (1.3 mm) satin coat galvanized sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides, and primed with a two (2) part acid based etching primer. Finish coat shall be an electrostatically applied enamel, at least three (3) mils thick, to all exposed surfaces. All joints shall be caulked with a water resistant sealant. |
| .2 | Units shall be provided with access doors to the fans, motors, filters, dampers, damper operators and gas controls. Doors shall be large enough for easy access, and shall be lift out style with two or more camlock fasteners. Units more than 48" (1200 mm) tall shall have hinged access doors with Ventlock 310 handles.  |
| .3 | Insulation shall be 1-1/2 lb./cu.ft. (24 kg/m) density, 1"   |

(25 mm) thick neoprene faced fibreglass with foil face where exposed to flame. Indoor units shall have the inlet section insulated. Outdoor units shall be completely insulated.

.3 Roof Curb

- .1 Provide full perimeter roof mounting seismic curb of heavy gauge sheet metal, minimum of 24" (600 mm) high, neoprene sealing strip, and fully welded "Z" bar with 1" (25 mm) upturn on inner perimeter, to provide a complete seal against the elements. External insulation of the roof mounting curb shall be provided by the Roofing Sub-contractor.

.4 Fans

- .1 Fans shall be forward curved DIDW centrifugal type 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 provided with a rust inhibiting coating.
- .2 Fans of 18" (450 mm) diameter or smaller shall have permanently lubricated bearings. Larger fans shall have greasable pillow block bearings.
- .3 Drives shall be adjustable on fans with motors 5 HP or smaller. On fans with larger motors, a fixed drive shall be provided. All drives shall be provided with a rust inhibiting coating. The manufacturer shall provide for one drive change (if required), during the air balancing procedure. Fan motors shall be open drip proof type.
- .4 Motor, fan bearings and drive assembly shall be located inside the fan plenum. Motor mounting shall be adjustable to allow for variations in belt tension.
- .5 Fan motor assemblies shall be provided with vibration isolators. Isolators shall be secured to welded steel channel and connected to the structural frame of the unit. The isolators shall be neoprene in shear type for fans up to 15" (375 mm) diameter and 1" deflection spring type with neoprene pads for larger fans.

.5 Burner Assembly

- .1 Provide a line type of gas burner capable of a modulating turn down ratio of thirty (30) to one (1).

- .2 Burner assembly and piping to include modulating flow ratio valve, fail-safe shut off valve(s), main and pilot pressure regulators, manual shut off valves and electrical pilot valve.

.6 Filters

- .1 Filter section 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 2" pre-filter and Merv 13 final filters enclosed in permanent galvanized metal frames.

.7 Dampers

- .1 Dampers shall be low leakage type of extruded aluminum or 18 gauge (1.3 mm) galvanized steel, with oilite or nylon bearings.
- .2 Interlocking edges and blade ends shall have neoprene foam or equivalent seals.
- .3 Inlet dampers shall be two position parallel blade type.
- .4 Provide at outdoor air intake.

.8 Electrical

- .1 All units shall be completely prewired including motor starter and overloads. The connection of electrical power supplies 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 non-fused main electrical disconnect switch.
- .4 Provide 120V/20A 5-20R weatherproof service receptacle within unit for field wiring by electrical contractor.

.9 Controls

- .1 Controls and gas manifolds shall be contained in a control panel that provides easy access to contained components.
- .2 Provide electronic ignition of pilot through a spark rod and electronically programmed flame supervision controller.
- .3 Safety devices shall include:
  - .1 Flame proving sensor
  - .2 high air velocity sensor
  - .3 low air velocity sensor
  - .4 high temperature limit.
- .4 Unit shall start from exhaust system interlock through the building automation system.

- .5 Provide a two (2) position, normally closed electric damper operator. This damper operator shall be interlocked so that when the unit is shut down, or on a power failure, the damper shall return to the closed position.
- .6 Modulating gas valve shall be controlled by a capillary tube and bulb type sensor. Discharge air temperature is set at the unit. Install and wire duct mounted sensor as per manufacturer's instructions.
- .7 Provide auto bypass low limit set at 40°F to shut down unit on flame failure.
- .8 Provide a remote panel containing:
  - .1 Heat ON/OFF switch and light.
  - .2 Fan ON/OFF switch and light.
  - .3 Flame failure light.
  - .4 Low limit light.
  - .5 Clogged filter light.
  - .6 Exhaust fan light.
- .9 Make-up air units shall be started/stopped from the BAS as well as supply air temperature setpoint adjusted through the BAS. Provide suitable BACnet controller for interface with BAS. Once activated, the unit shall control its dampers, fans and heaters through the unit's internal controller to maintain the supply air temperature setpoint.

2.2 Kitchen Indirect  
Gas Fired/DX Cooling  
MAU-1 & 2

- .1 Shall be as per the Welding Shop make-up air unit, but with the following:
  - Indirect fired burner
  - Recirculation and make-up air unit operating modes with dampers
  - DX cooling coil with remote condensing unit.
  - Motorized damper also at return air opening.
- .2 Heating shall be indirect natural gas fired. The entire package including damper controls, fan controls, and all other miscellaneous controls and accessories shall be pre-wired, and factory certified by an approved testing agency such as ETL, UL, or CSA for the destination. Heat exchanger shall be a primary drum and multi-tube secondary assembly constructed of titanium stainless steel with multi-plane metal turbulators and shall be of a floating stress-relief design. Heat exchanger shall be provided with a condensate drain connection. Heat exchanger casing shall have 1" (25 mm) of

insulation between the outer cabinet and the inner heat reflective satin coat galvanized steel liner. Blower location shall be engineered to optimize the required air flow pattern around the heat exchanger. Duct type furnaces with close-coupled blowers are not acceptable. The heat exchanger and burner assembly shall include 15:1 turndown for all input ranges.

- .2 Cooling coil drain pans shall be fabricated of 18 ga (1.3 mm) 304 stainless steel and are an integral part of the floor paneling, a minimum of 2" (51 mm) deep with welded corners. Drain pans shall extend a minimum of 6" (152 mm) downstream of the coil face and be provided with a 1.5" (38 mm) stainless steel MPT drain connection. All cooling coil drain pans shall have a fast pan and be sloped and pitched such that there is no standing water. Intermediate drain pans shall be provided where required for effective moisture removal.
- .3 Evaporator coils shall have 1/2" (13 mm) outer diameter tubes. Fins constructed of aluminum or copper shall be corrugated 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 hydronic and refrigerant coils shall be factory tested with air at 300 psig (2068 kPa) while immersed in an illuminated water tank. All condenser refrigerant coils shall be factory tested with air at 600 psig (4482 kPa) while immersed in an illuminated water tank.
- .4 The remote condensing unit, including fan controls, head pressure control, and all other miscellaneous controls and accessories shall be pre-wired, and factory certified by an approved testing agency such as ETL, UL, or CSA for the destination. Condensing unit shall be controlled from the main unit controller. Unit shall be supplied with electrical disconnect switch.

## PART 3 - EXECUTION

### 3.1 Installation

- .1 Install units in accordance with manufacturer's recommendations.
- .2 Provide all interconnecting wiring to remote control panels, remote control devices, as required to make unit fully functional. Wiring not shown as by Division 16 shall be provided by Division 15.

- .3 Installation and venting provisions for gas fired units must be in accordance with CGA Standard B149.1. Type A, C, or PS venting is required on indoor indirect fired units.
- .4 Maintain the required clearance to combustibles for gas fired units as recommended by the manufacturer.

END OF SECTION



## PART 1 - GENERAL

- |                        |    |   |
|------------------------|----|---|
| <u>1.1 General</u>     | .1 | Conform with requirements of front end Sections 00 and 01 as they apply to the work of this discipline. |
|                        | .2 | Comply with the minimum efficiency requirements outlined in ASHRAE 90.1-10.                             |
| <u>1.2 Warranty</u>    | .1 | Manufacturer shall provide unit with factory start-up and warrant unit parts for (5) year parts.        |
| <u>1.3 Spare Parts</u> | .1 | Furnish two sets of spare filters for each unit.  |

## PART 2 - PRODUCTS

- |                    |    |  |
|--------------------|----|--|
| <u>2.1 General</u> | .1 | Floor mounted, vertical upflow configuration classroom ventilator. Exterior wall mounted unit will not be acceptable.  |
|                    | .2 | Internal design including fresh air intake and condensing fan relief through exterior wall louver.   |
|                    | .3 | Units shall be CSA, UL or ETL certified and labeled indicating that the equipment has been independently tested and meets the applicable safety standards required in Canada. Units shall be manufactured by a company manufacturing ventilation equipment for at least ten years. |
|                    | .4 | Acceptable Manufacturer: Changeair/Systemair.  |
| <u>2.2 Cabinet</u> | .1 | Cabinet construction should be such that internal 16-gauge frame supports all internal metal pans and components. Exterior panels should not support any internal components.  |
|                    | .2 | The outer cabinet doors shall be constructed of 18-gauge steel and the sides from 20-gauge steel with a powder coat baked enamel-textured finish. The cabinet panels shall attach to the frame without visible screws, rivets or fasteners.  |
|                    | .3 | The cabinet front shall incorporate two fully insulated full sized hinged panels held closed by no less than two tamper resistant cam locks.   |

- .4 Cabinet panels shall be thermally/acoustically insulated with 1"(2.54 cm) thick flexible fiberglass insulation, covered in the air stream with a black coated mat. All exposed edges to be sealed. Density to be a minimum of 1.5 lb/ft<sup>3</sup>. Insulation shall comply with 25/50 Flame Smoke requirement as per UL 1995/ CSA 22.2 No. 236 standards in addition to UL94-HF-1 flame rating. Insulation with only UL94-HF-1 flame rating is not acceptable.
- .5 Units shall be provided for ducted supply air, or be supplied with top mounted supply air plenum and double deflection supply air grilles, as indicated on the drawings.

### 2.3 Filters

- .1 Units shall be equipped with a 2" Merv 13 pleated disposable filter. The location of the filter shall provide 100% filtration of both re-circulated and outside fresh air.

### 2.4 Fans

- .1 Supply motor and fan Assembly shall consist of two fan bodies to supply the specified cfm. Each fan body shall be a double inlet centrifugal type blower with the two fans driven by one electrically commutated motor (ECM). The ECM shall be programmed to deliver the specified airflow at the rated external static pressure. Standard permanent split capacitor (PSC) motors will not be acceptable. The supply ECM fan control board shall accept either a direct 0-10 VDC analog control signal for full modulated control of the fan output or a 24 VAC digital signal for required fan output.
- .2 The supply fan shall be orientated in a design position such that the mixed air will be drawn through both the heating and cooling coils before reaching the supply fan.
- .3 Supply fan motor shall be isolated from the supply fan by using the metal motor mount bracket and rubber insulator. Fan assembly slider shall sit on felt insulation in two fan bodies.
- .4 The condensing motor and fan assembly shall cool the condensing coil and also be designed in such a way as to relieve stale room air at the same rate at which outside air is entering the room. The assembly shall be a single body backward curved centrifugal fan driven by an integral electrically commutated motor (ECM). PSC motors will not be acceptable.

.5 A duct collar shall be supplied with the unit ventilator for connection of ductwork. The unit fan system shall be sized to allow a minimum of 62 Pa ESP (0.25" w.g).

.6 The unit shall be supplied with punched return grille openings.

### 2.5 Cooling

.1 All refrigerant components shall be factory installed and connected, requiring no field fabrication or installation of coils, line-sets or condensing units.

.2 A direct expansion (DX) coil shall be provided in the evaporator coil section, and matching condensing coil in the condenser section. The coils shall be CSA/UL certified consisting of copper tubes mechanically burred to .006" with corrugated aluminum fins permanently bonded to the tubes to prevent electrolytic action. The end plates shall be of galvanized steel construction. Each coil shall be leak tested and commercially cleaned and dehydrated. The coils shall be correctly sized for their respective airflows and matched to the unit's compressor to provide the cooling capacity required by the schedule at the maximum efficiency for the system.

.3 The drain pan shall be stainless steel designed with both front to back and side to side slopes to the primary drain outlet eliminating any standing water in the pan.

.4 Units shall be equipped with a factory installed, hermetically sealed, scroll type compressor sized to match the coils and provide the specified capacity. The compressor shall be double isolated to reduce vibration transmission. The compressor shall be protected from excessive motor temperature and current by means of an internal overload protector. A high-pressure switch shall disable the compressor if excessive system pressure is achieved. A low pressure cut out shall also be provided to disable the compressor if refrigerant pressure is below acceptable threshold.

.5 Each unit shall be equipped with a Compressor Crankcase Heater to prevent migration and mixing of refrigeration with the oil in the crankcase.

.6 Each unit will be factory equipped with a hot gas reheat coil positioned on the leaving side of the evaporator coil. When the solenoid is energized maximum system dehumidification will be enabled by reheating the discharge air to near room temperatures.

- .7 The cooling system shall operate in a three stage cooling sequence. First stage free cooling shall be economizer to provide up to 100% nominal outside air whenever the outdoor temperature is below 60 degrees. Second stage shall be mechanical cooling with "first stage" for 2/3 capacity. Third stage shall be 100% mechanical cooling.
- .8 Units shall be supplied with a factory installed and wired internal condensate pump, suitable to pump the condensate to the existing high-level condensate piping within each classroom.

#### 2.6 Heating

- .1 The unit shall be supplied with an electric heating coil with SCR controller for modulation.

#### 2.7 Dampers

- .1 The dampers shall be a low leakage parallel blade design. The frame and blades shall be constructed of extruded aluminum with blade design being streamline or airfoil construction, operated by zero maintenance, concealed linkage, 1/2" axles bolted to the blades shall operate on bronze oilite bearings. Both blade edge and jamb seals shall be of the pressure sensitive type for low leakage.
- .2 The damper shall be equipped with a Belimo spring return damper actuator. The actuator must provide proportional damper control. Actuators shall use a brushless DC motor controlled by a microprocessor and be protected from overload at all angles of rotation. The outdoor damper actuator shall fail in the closed position.
- .3 The damper actuator shall allow outside air to mix with return air, the volume of outside air during the occupied period to be fixed to a minimum outside air as per the equipment schedule. The damper shall have the capability of opening during an economizer cycle to allow a minimum 80% of the total supply air through the outside air damper.

#### 2.8 Energy Recovery Wheel

- .1 The recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belt. The energy recovery wheel shall be coated with silica gel desiccant permanently bonded. The substrate shall be lightweight polymer. Coating segments shall be washable and desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.

- .2 Thermal performance of the energy wheel shall be certified by the manufacturer in accordance with ASHRAE Standard 84 and shall be listed in the ARI Certified Products.
- .3 Fresh air supply shall be mechanically drawn through the wheel by the supply fan. Relief air volume through the wheel shall be at the same rate and capacity that outside air is entering the room.
- .4 Frost protection for the ERW is provided by ensuring the relief air from the wheel stays above the frost threshold (22F). In the event the air temperature drops, the relief fan shall ramp up keeping the air temperature above the threshold.
- .5 A dual pressure transducer shall be supplied for units. This device shall measure the pressure drops for the intake and relief sides of the ERW to ensure accurate airflow in both air streams. The device combined with the ECM relief fan shall make the ERW self balancing.

## 2.9 Environmental Controls

- .1 The unit shall have a microprocessor based control system with automatic control and monitoring capability. The control system shall use Proportional + Integral + Derivative (PID) control algorithms capable of maintaining the temperature to a tolerance of  $\pm 1^{\circ}\text{F}$ .
- .2 Provide a terminal strip for interface with the existing BACnet Building Automation System as per school standards.
- .3 The controller must also be able to run standalone and occupancy determined by an internal weekly and annual schedule.
- .4 The controller must operate from a wall mounted room temperature sensor. This sensor will sense the temperature in the room and provide an operator interface with limited programming adjustments and over-rides. Coordinate requirements with the building automation system (BAS) contractor.
- .5 The unit shall have a built-in carbon dioxide (CO<sub>2</sub>) sensor monitoring the CO<sub>2</sub> concentration of the return air to control

ventilation. The sensor shall be monitored by the building automation system (BAS).

- .6 The BAS shall work in conjunction with the classroom ventilator heating system to activate the perimeter hot water radiator control valve whenever space heating is required.

#### 2.10 Condensate Pump

- .1 Units shall be supplied with an internal factory installed and wired condensate pump to suit exterior wall louver installation height, as well as where piped condensate drainage is indicated on the drawings.
- .2 Condensate pump shall not be provided where gravity drainage through the exterior wall louver is possible

#### 2.11 Electrical

- .1 The main power supply shall connect to the unit through a wire race way directly to either a terminal block or to the unfused disconnect provided by the unit manufacturer.
- .2 Each unit shall be supplied with a line voltage service disconnect and a door switch for control voltage interrupt to disable the mechanical components when the service panel is removed. The disconnect switch shall be lockable in off position.
- .3 All internal functions must be fuse protected by a time delay fuse properly rated for the amperage load.

### PART 3 - EXECUTION

#### 3.1 General

- .1 Install where indicated in accordance with manufacturers' installation instructions, respecting and maintaining the recommended service clearances. Install units level and plumb, anchored to the floor or support structure in accordance with the earthquake restraint requirements of the code.
- .2 The Manufacturer's representative shall certify in writing that the installation has been completed in accordance with the manufacturer's recommendations.
- .3 Run drain line from cooling coil condensate drain pump through

exterior wall louver for ground and second floor units, and to internal condensate drain pipe for second floor units where indicated.

- .4 Install on neoprene pads.
- .5 Disassemble and reassemble units as required to suit site conditions.

### 3.2 Louver Connection

- .1 All units will require a custom ducted connection to the exterior wall louvers with internal separator for the intake and exhaust air streams. Louver sizes and installation heights vary throughout the project to suit window openings and other conditions.
- .2 Prior to fabrication of any custom ductwork connections, submit a separate construction coordination sketch as shop drawing for every unit for review. Obtain approval of the construction detail by the unit manufacturer prior to submitting shop drawings.
- .3 Unit ventilators shall be installed as close to the exterior wall as possible to minimize impact on the classroom.

### 3.3 Filters

- .1 Contractor shall replace filters prior to turning the building over to the owner

### 3.4 Start-up

- .1 The manufacturer's agent shall be responsible for overseeing and reviewing the installation prior and after the initial start-up. The agent shall also demonstrate to the building maintenance personnel the operation of the units and explain warranty procedures.

### 3.5 Equipment Preparation

- .1 Provide services of factory trained start-up technician licensed for commercial refrigeration equipment. Provide written start-up report to demonstrate the proper operation and correct settings of the units.

END OF SECTION





## PART 1 - GENERAL

### 1.1 General

- .1 Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.
- .2 The “provide” in this Division shall be interpreted as “supply and install”.
- .3 All work shall conform to Canadian Metric Practice Guide CSA CAN 3-2234.1.76.
- .4 Provide all required adapters between metric and imperial components.
- .5 Metric descriptions in this Division are nominal equivalents of Imperial values.
- .6 All equipment and material to be new, CSA certified, manufactured to minimum standard quoted including additional specified requirements.
- .7 Where there is no alternative to supply equipment which is not CSA certified, submit such equipment to Inspection. Authorities for special inspection and obtain approval before delivery of equipment to site.
- .8 Use material and equipment available from a regular production by manufacturer concerned.

### 1.2 Contractor

- .1 Acceptable Contractors:

Company Name	Contact Person	Phone Number	Address	Fax Number
Ainsworth	Angel Medina	<a href="tel:613.296.7150">613.296.7150</a>	69 Auriga Dr, Ontario K2E 7X7	
Honeywell	Jim Keesling	416-758-2820		416-758-2740
AIRON (previously Lar-Mex)	Eric Montambeault	613-747-1563	4-5509 Canotek Road, Ottawa, ON K1J 9J8	613-747-2435
Regulvar	Stephan Riffault	613-565-2129	1250 Old Innes Rd. Unit 518, Ottawa, ON K1B 5L3	613-565-8895
Trane	Steve Meincke	613-820-8111	1024 Morrison Drive, Ottawa, ON K2H 8H7	
	Matt Flansbury	613-744-5396	1257 Algoma Rd Unit 2, Ottawa, ON K1B 3W7	
B. Lundy Mechanical (Carmichael)	Brian Lundy (Mike Hansen)	613-342-7820	3528 Coons Road, Brockville ON, K6T 1A7	613-342-9048

### 1.3 Scope of Work

- .1 The work covered by this specification and related sections consists of providing shop drawings, equipment, labour, materials, engineering, technical supervision, and transportation as required

to connect the new systems and modifications to the existing systems into the existing building automation system as required to complete the scope of this project, matching the school board standards. The contractor is responsible to review the existing installation on site prior to submitting bid. If the contractor is unable to connect, modify and integrate their systems into the existing installation, furnish and install a fully operational BACnet IP BAS to monitor and control the facilities listed herein, and as required to provide the operation specified in strict accordance with these documents, and subject to the terms and conditions of the contract. The work in general consists of but is not limited to, the following:

- .1 Remove all existing controls equipment and systems that have become redundant from the demolition of existing mechanical equipment and systems.
  - .2 The preparation of submittals and provision of all related services.
  - .3 Operator work stations located as listed in the specifications.
  - .4 Furnish and install Network Control Units (NCU's), any additional new control devices, conduit and wiring, in the facility as required to provide the operation specified.
  - .5 Furnish and install new Terminal Control Units.
  - .6 Furnish and load all software required to implement a complete and operational BAS.
  - .7 Furnish complete operating and maintenance manuals and field training of operators, programmers, and maintenance personnel.
  - .8 Perform acceptance tests and commissioning as indicated.
  - .9 Provide full documentation for all application software and equipment.
  - .10 Miscellaneous work as indicated in these specifications.
- .2 The sequence of operation provided in the specification is to be used to identify controls/sensors of equipment, systems, etc. to be included in the BAS. The contractor shall supply all control points and peripheral devices required to facilitate the sequence of operation described or indicated, whether or not specifically shown on drawings and schematics.
- .3 The Contractor shall provide all 120 volt relays and contactors required for specified operation, unless shown in the electrical drawing package.

1.4 School Board  
Requirements

- .1 Floor plans and graphics shall be provided for all systems indicating locations and all input/output points. Overridden values shall be in purple. Alarms shall be in red.

1.5 Permits,  
Fees and Codes

- .1 Apply for, obtain and pay for all permits, licenses, inspections, examinations and fees required. Also submit, if required, information and other data that may be obtained from the Consultant. Should the authorities require the information on specific forms, fill in these forms by transcribing the information provided by the Consultant.
- .2 Arrange for inspection of all work by the authorities having jurisdiction over the Work. On completion of the Work, present to the Consultant the final unconditional certificate of approval of the inspecting authorities.
- .3 Comply with the requirements of the latest edition of the applicable ULC or CSA standards, the requirements of the Authorities, Federal, Provincial/Territorial and Municipal Codes, the applicable standards of ULC and all other authorities having jurisdiction. These Codes and Regulations constitute an integral part of these Specifications.
- .4 Where there is no alternative to supply equipment which is CSA certified, submit such equipment to the local electrical authority for special inspection and obtain approval before delivery of equipment to site.
- .5 In case of conflict, applicable Codes take precedence over the Contract Documents. In no instance reduce the standard or Scope of Work or intent established by the Drawings and Specifications by applying any of the Codes referred to herein.
- .6 Before starting any work, submit the required number of copies of documentation to the authorities for their approval and comments. Comply with any changes requested as part of the Contract, but notify the Consultant immediately of such changes, for proper processing of these requirements. Prepare and furnish any additional drawings, details or information as may be required.

1.6 Coordination

- .1 All work shall be performed at times acceptable to the Consultant. Provide work schedule at the start of the job for the approval of the Consultant. Schedule shall show when all staff and sub-contractors shall be on-site.
- .2 Organize all sub-contractors and ensure that they maintain the schedule.
- .3 Full cooperation shall be shown with other sub-contractors to facilitate installations and to avoid delays in carrying out the work.
- .4 Notify Consultant of any changes to the schedule. Send any schedule changes and weekly progress reports in PDF format via email to Consultant.
- .5 Where, in the judgement of the Consultant, the work could disrupt the normal operations in or around the building, contractor shall schedule work to eliminate or minimize interference.
- .6 When connecting to the existing systems, advise the Consultant and obtain permission to so. Perform work at a time acceptable to the Consultant and Owner.

1.7 Work in  
Occupied  
Building

- .1 Do work to best suit available space and not interfere with or obstruct use of existing facilities.
- .2 Cut, cap-off, modify, or extend as necessary or as directed by the Consultant existing material or equipment to be removed, re-used or relocated to work under this contract. Remove all redundant wiring and devices.
- .3 Provide any connections required to maintain services throughout the building. Supply and install all necessary material and equipment and all labor at no extra cost. Should any existing system be damaged, make full repairs without extra cost, and to the satisfaction of the Consultant as quickly as possible. If this requires work outside of normal hours, this shall be carried out at no extra cost.

- .4 Contractor shall provide temporary lighting and power where necessary.
- .5 Where disruptions of existing mechanical or electrical services are required, coordinate shutdown with the Consultant and do the work at a time and in a manner mutually acceptable. Carefully schedule disruptions to keep down time and disturbances to occupants to a minimum. Consultant reserves the right to modify the schedule at his discretion to keep down time and disturbances to occupants to a minimum.
- .6 Submit a concise written schedule of each disruption at least seventy-two (72) hours in advance and obtain Owner's written consent prior to implementation.
- .7 Contractor shall follow all security precautions stipulated by the Owner.
- .8 No system downtime shall be permitted within one (1) hour of regular working hours during weekdays (i.e. 0700 - 1800 hours) without prior permission of Owner.
- .9 All on-floor system installation and commissioning work and work in public spaces to be executed under this contract is to be performed between 1800 hours of one day and 0600 hours of the following day or on weekends from 1800 hours on Friday until 0600 hours on the morning of the next regular working day, normally Monday or Tuesday if Monday falls on a long weekend.
- .10 Notify Owner twenty-four (24) hours before disabling any existing building alarms.

#### 1.8 Supervision of Personnel

- .1 Maintain at this building qualified personnel and supporting staff with proven experience in erecting, supervising, testing, and adjusting projects of comparable nature and complexity.
- .2 Supervisory personnel and their qualifications are subject to the approval of the Owner.

- .3 All personnel working on-site shall sign in as required by the Owner and shall wear company identification.
- .4 When requested and for whatever reason, remove personnel and/or support staff from project. Take immediate action.

#### 1.9 Expediting

- .1 Continuously check and expedite delivery of equipment and materials. If necessary, inspect at the source of manufacture.
- .2 Continuously check and expedite the flow of necessary information to and from all parties involved.
- .3 Immediately inform the Consultant if information is required from him.

#### 1.10 Use of Site

- .1 Access the site, park vehicles and locate storage as directed by the Consultant. The Consultant shall not take any responsibility for any materials that are damaged, lost or stolen.
- .2 Do not interfere with normal access to or egress from the site or building.
- .3 Obtain Owner's permission relative to use of on-site power, telephones and the like. The Owner shall pay for all used by the Contractor in the performance of the Work.

#### 1.11 Existing Systems and Equipment

- .1 The Contractor is responsible for conducting his own inspection to determine the proper operation of existing equipment and systems prior to commencement of the work that may adversely affect the operation of the controls equipment, within thirty (30) days of award of contract. The Contractor shall provide a report of their findings to the Consultant and building owner prior to commencement of the work and obtain direction for any remedial work. Upon receipt of notification of equipment malfunctions, the Owner shall have the option of repairing the equipment himself or provide appropriate instruction to the contractor to perform the work under the current contract.

- .2 Any damage to the Owners mechanical equipment after the Contractor's inspection and/or repair of the Owner's mechanical equipment, which in the judgement of the Consultant can be traced to the installation of the work, shall become the responsibility of the Contractor to repair at his cost.
- .3 The Contractor shall be entirely responsible to determine the suitability of all wiring and conduit to be reused, during the tender process. No claim for extras shall be entertained regarding damaged, inoperative or unsuitable wiring.

1.12 Fire  
Protection

- .1 Provide and maintain temporary fire protection equipment during performance of work as required by applicable Codes, Regulations and good construction practice.
- .2 Open fires and burning rubbish are not permitted.

1.13 Cutting and  
Patching

- .1 Provide cutting, patching, repair, painting and refinishing of existing walls, floors, ceilings, roofs, materials equipment, etc. as required for the retrofit construction. Patch holes in mechanical room and throughout the building if they are not re-used in the work. Provide new or enlarged holes as necessary in a manner that retains structural integrity and fire rating.
- .2 The Contractor shall be responsible for removing and re-installing ceiling tiles in all areas where access to suspended ceiling space is required. The Contractor shall replace ceiling tiles damaged during construction. The Contractor shall take due care and caution to minimize damage to all architectural elements affected by construction.
- .3 At the end of each work day, the Contractor shall clean up any debris, equipment and supplies and store them in an area designated by the Consultant.
- .4 It shall be the responsibility of the Contractor or his sub-contractor to ensure that any coring of holes through the walls or floors will not penetrate existing conduits, cables or mechanical equipment in or

under the floor slabs or walls. He shall be responsible to take any and all action as deemed necessary by the Consultant to correct any such penetrations at his cost. No coring shall be undertaken unless permission is given by the Consultant. Scan walls and floors prior to core drilling to identify hidden piping. Ensure that water does not flow into equipment and below floors. Waterproof and fire stop all penetrations.

#### 1.14 Demolition/ Removal

- .1 Disconnect and dismantle all materials and equipment not required for the operation of the work or where improperly installed.
- .2 All existing control panels, end devices whether pneumatic, electronic or electric and all associated piping and wiring which becomes redundant or obsolete by the installation of the work, shall be removed in a manner to minimize damage to the building structure and to the material being removed.
- .3 Contractor shall ensure that all DDC panels, cabinets and field devices remain intact or are recovered intact so they can be re-used. Repair or replace at his cost any DDC panels, cabinets and field devices damaged by the Contractor.
- .4 Contractor shall ensure that all other non-DDC devices or controls remain intact or are recovered intact so they can be re-used.
- .5 All removed equipment resulting from the work, shall be come the property of the Owner unless otherwise indicated. Owner shall examine the materials and equipment that he wants to salvage. Contractor shall remove all materials that the Owner does not wish to salvage from the site and shall dispose of same in an approved manner by authority having jurisdiction.

#### 1.15 Ceiling Tiles

- .1 Contractor shall report any missing or damaged ceiling tiles to the Owner in writing prior to commencement of work. Upon receipt of notification of missing or damaged ceiling tiles, the Owner shall have the option of promptly correcting the problem himself or he shall issue a Change Order to have the Contractor do the repairs.



- .2 Contractor shall reinstall all ceiling tiles that were removed to install the work in a manner that meets local Fire Code requirements.
- .3 Contractor is responsible for replacing and making good to the satisfaction of the Owner all T-bar ceilings as well as primary and secondary mains damaged as a result of the installation of the work.
- .4 Any damage to the ceiling tiles after the Contractor's inspection and/or repair of the Owner's equipment, which in the judgement of the Owner's can be traced to the installation of the work, shall become the responsibility of the Contractor to repair at his cost.

1.16 Spare Capacity

- .1 Each NCU and LCU controller shall have a minimum of 20% spare capacity for future points.
- .2 Each NCU and each LAN shall have the capability of accepting 20% additional terminal control units without the necessity of adding additional LAN controllers or LAN wiring.
- .3 Provide details of the spare capacity on each device and LAN.

1.17 Power Supply

- .1 The power supply for the entire BAS system shall be taken from local 120 volt branch panels by this contractor. BAS components serving equipment operating on emergency power shall be powered from local emergency power 120 volt branch panels.
- .2 All network controllers and each OWS shall have UPS backup for fifteen (15) minutes.

1.18 Abbreviations and Symbols

- .1 All letter symbols and engineering unit abbreviations utilized in information displays ANSI/ISA S5.5 and printouts shall conform to ANSI 710.19/IEEE 260 letter symbols for SI and certain other units of measurement.

1.19 System Design

- and Responsibility .1 The drawings do not show conduit size or wire type to link the various elements of the system. The BAS contractor is responsible for designing these links in view of the present and future capabilities.
- .2 The Contractor is responsible for supplying sufficient Controllers of all types to meet the intent of the specification. The quantity and point content of the Controllers must be approved by the Consultant prior to point installation.
- 1.20 Products .1 Materials and equipment shall be essentially the catalogued products of manufacturers regularly engaged in production of such materials or equipment and shall be manufacturer's latest standard design that complies with the specification requirements. Where two units of the same class of equipment are required, these units shall be products of a single manufacturer, however the component parts of the system need not be the products of a single manufacturer. Each major component of equipment shall have the manufacturer's name and address and the model and serial number on a nameplate securely attached in a conspicuous place.
- 1.21 Electrical Work and Safety Requirements .1 Electrical work shall be in accordance NFPA 70, ANSI C2, and the Canadian Electrical Code. Electrical wiring, terminal blocks and other high voltage contacts shall be fully enclosed or properly guarded and marked to prevent accidental injury to personnel.
- 1.22 Manufacturer's Recommendations .1 Where installation procedures, or any part thereof, are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Consultant with shop drawing submission. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations shall be cause for rejection of the material.
- 1.23 Wiring .1 All wiring associated with and required by the BAS shall be the responsibility of this contractor. The term "wiring" shall be

construed to include furnishing of wire, conduit, miscellaneous material and labour as required to install a total working system. If departures from the contract documents are deemed necessary by the contractor, details of such departures, including changes in related portions of the project and the reasons therefore, shall be submitted with the drawings to the Consultant for approval.

- .2 All wiring shall conform with the most stringent requirements of the local electrical authority, the Ontario Building Code, or the Canadian Electrical Code.
- .3 The cabling riser infrastructure shall be installed in base building mechanical rooms or janitor's rooms, not within tenant spaces.

#### 1.24 Lockable Panels

- .1 All Controller panels shall be NEMA rated to environment requirements, with hinged doors and equipped with standard keyed-alike cabinet locks, keyed to same key.

#### 1.25 Nameplates

- .1 Nameplates shall be provided for all control items listed or shown in the submittal and approved control diagrams. Each inscription shall identify its function, such as "mixed air controller", "cold deck sensor" in both official languages etc. and when applicable, its position. Size of nameplates shall be 25 mm by 67 mm minimum. Lettering shall be minimum 7 mm high normal black lettering. Submit duplicate samples, in both official languages, of identification tags and lists of wording proposed for approval.

#### 1.26 Verification of Dimensions

- .1 The contractor shall thoroughly familiarize himself with all details of the work and working conditions and verify all dimensions and shall advise the Consultant of any discrepancy before performing any work or purchasing any equipment. The Contractor shall be specifically responsible for the co-ordination and proper relation of his work to the building structure and to the work of all trades.

#### 1.27 Preliminary Design Review

- .1 The BAS contractor shall submit a preliminary design document for review. This document shall contain the following information:

- .1 Specification sheets for each piece of equipment proposed.
  - .2 Layout of equipment in control centre.
  - .3 Single line diagram showing cable routing between control centres, field cabinets.
  - .4 Description of system operation including speed and type of data transmission used, type of cable or wire used, operator action necessary to execute commands, obtain data displays, or respond to alarms, automatic features provided.
  - .5 System capacity and limits of expansion
  - .6 Type and size of memory with statement of spare capacity.
  - .7 Description of software programs included.
  - .8 Samples of displays, reports and logs, and samples of operator instruction manual.
- .2 The contractor shall convene a design review meeting within thirty (30) working days of contract award to review the following:
    - .1 Functional review of the preliminary design document to resolve inconsistencies.
    - .2 Clarification of any ambiguities between contractual document information and actual items
    - .3 General approval to proceed with the system concept as proposed.
    - .4 Approval to order long-lead items.

#### 1.28 Drawing Requirements

- .1 Within forty-five (45) days of award of contract and before start of construction, submit three (3) hard copies and one (1) soft copy of manufacturers information and shop drawings. Soft copy to be in AutoCAD and WordPerfect formats (latest versions) structured using menu format for easy loading and retrieval on the OWS.
- .2 Manufacturer's Data  
Provide in completely coordinated and indexed package to assure full compliance with the contract requirements. Piecemeal submittal of data is not acceptable and such submittals will be returned without review. Information shall be submitted for all material and equipment the contractor proposes to furnish under terms of this contract work. Arrange the submittals in the same sequence as these specifications and reference at the upper right-hand corner the particular specification provision for which each submittal is intended. Submittals for each manufactured item shall be manufacturer's descriptive literature (equipment specification),

equipment drawings, diagrams, performance and characteristic curves, and catalog cuts, and shall include the manufacturer's name, trade name, catalog model or number, nameplate data, size layout dimension, capacity, specification reference, applicable specification references, and all other information necessary to establish contract compliance.

.3 Shop drawings

Provide in completely coordinated and indexed package:

- .1 Wiring and piping diagrams.
- .2 Control schematics with narrative description and control descriptive logic fully showing and describing operation and/or manual procedures available to operating personnel to achieve proper operation of the building, including under complete failure of the BAS.
- .3 Shop drawings for each input/output point showing all information associated with each particular point including sensing element type and location; details of associated field wiring schematics and schedules; point address; software and programming details (CDL's) associated with each point; and manufacturer's recommended installation instructions and procedures for each type of sensor and/or transmitter.
- .4 Detailed system architecture showing all points associated with each controller, controller locations, and describing the spare points capacity at each controller and LAN
- .5 Specification sheets for each item including manufacturer's descriptive literature, drawings, diagrams, performance and characteristic curves, manufacturer and model number, size, layout, dimensions, capacity, etc

1.29 Start-up and Checkout

- .1 This work shall include field testing and adjustment of the complete BAS, and on-site final operational acceptance test of the complete operational BAS. The Consultant shall be advised at least fourteen (14) days in advance of the dates of all tests and may attend at his discretion. If the Consultant witnesses the test, such tests shall be subject to his approval prior to the release of equipment. If the Consultant elects not to witness the tests, performance certification shall be provided by the contractor. Acceptance of tests by the Consultant shall not relieve the contractor of responsibility for the complete system meeting the requirements of these specifications after installation.

.2 Static testing

- .1 Static testing shall include point by point testing of the entire system and completion of Component Test Sheets. The contractor shall forward proposed Test Sheets at the shop drawing review stage. These Component Test Sheets shall be completed during the contractor's own testing and verification procedure that is done prior to the request for a final inspection. The completed Component Test Sheets shall then be returned to the Consultant for review and approval. The Consultant may repeat a random sampling of at least 20% of the tests during the Consultant's commissioning procedure to corroborate their accuracy. The Contractor shall be on site with test equipment during this verification process. The test procedures shall include the following.
- .2 Digital input component test sheet
  - .1 DI status shall be verified at the POT and OWS for ON and OFF status
  - .2 All digital alarm inputs shall be proven using actual field conditions where possible or be jumpered at the field device for testing with the approval of the Consultant.
- .3 Digital output component test sheet
  - .1 Status to be verified at the equipment location. Verification at the OWS shall be completed for ON and OFF status, software DISABLE indicator and OVERRIDEN indicator.
- .4 Analog input component test sheet
  - .1 all temperature sensors shall be calibrated using a handheld meter with equal or better accuracy
  - .2 selected temperature sensors chosen by the Consultant shall be verified by spraying with a "cold spray" or other means to ensure response and to test the low temperature alarm condition
  - .3 all pressure sensing devices and analog output feedback shall be verified using a device with equal or better accuracy to ensure correct calibration.
  - .4 all humidity sensing devices must be verified using a recently calibrated device with equal or better accuracy
  - .5 all CT's shall be set to accurately reflect motor status, including removing belts on belt driven equipment

- .6 all other devices shall be verified using appropriate devices of equal or better accuracy
- .7 adjust span on feedback devices so that input matches the end device
- .5 Analog output component test sheet
  - .1 AI points shall be tested by sending a command from the POT or OWS to incrementally stroke the field device from full CLOSED to full OPEN and measuring the signal at the field device. The increments of the test shall be no larger than 10% of the output span.
  - .2 The AO feedback requirement shall also be tested by failing the field device and verifying that the alarm registers
  - .3 Each output shall be exercised over the full output capability of the panel
  - .4 Field device hysteresis shall be measured at a minimum of three output levels for each direction of travel. Output increments shall not exceed 2% of span for this test

.3 Dynamic Operational Test

A dynamic operational test of not less than thirty (30) consecutive days, twenty-four (24) hours per day, shall be conducted on the complete and total installed and operational BAS to demonstrate that it is functioning properly in accordance with all requirements of this specification. The correct operation of all monitored and controlled points shall be demonstrated as well as the operation and capabilities of all sequences, reports, specialized control algorithms, diagnostics, and all other software. If the equipment operates at an average effectiveness level (AEL) of at least 98% during the performance test period of thirty (30) consecutive calendar days, it will be deemed to have met the standard of performance, and final acceptance of the system shall be made, provided the contractor has satisfied all other requirements of this specification. In the event the required AEL is not reached during the initial thirty (30) consecutive calendar day period, the final operational acceptance test period shall be extended on a day-to-day basis until the required AEL is reached for thirty (30) consecutive calendar days.

- .1 The AEL is defined as the ratio between the total thirty (30) day test period less any system downtime accumulated within that period, and the thirty (30) day test period. Downtime shall result whenever the BAS is unable to fulfil all

required functions detailed within this specification due to any malfunction of either hardware or software. Any defect of hardware or software shall be corrected when it occurs before the test may be resumed. System downtime for each incident shall be measured by those intervals during the performance period between the time that the contractor or duly authorized representative is notified of equipment failure and the time that the system is returned to proper operating condition. Downtime of the system resulting from the following causes will not be considered as system failures:

- .2 Downtime resulting from an outage of the main power supply in excess of the capability of any back-up power source(s) provided that the automatic initiation of all back-up sources was accomplished and provided that the automatic shutdown and restart of components fulfils the requirements of this specification.
- .3 Failure of a communications link, provided that the failure was not due to a failure of the contractor-furnished equipment.
- .4 Downtime resulting from the failure of connected equipment.
- .5 A functional failure resulting from an individual sensor or controller provided that the system has recorded the fault, the mechanical equipment is defaulted to the fail-safe mode, and that the AEL of the total of sensors and controllers is at least 99% during the thirty (30) day test period.

### 1.30 Standards Compliance

- .1 Where materials or equipment are specified to conform to requirements of the standards of organizations, such as the Canadian Standards Association (CSA) that use a label or listing as method of indicating compliance, proof of such conformance shall be submitted and approved, indexed and cross-referenced with the specification. The label or listing of the specified organization will be acceptable evidence. In lieu of the label or listing, the contractor shall submit a certificate from a testing organization adequately equipped and competent to perform such services, and approved by the Consultant, stating that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard or code. For materials whose compliance with organizational standards or specifications is not regulated by an organization using its own listing or label as proof of compliance, a certificate from the



manufacturer shall be furnished to the Consultant stating that the material complies with the applicable referenced standard or specification.

1.31 Final  
Acceptance

- .1 Final acceptance shall commence only after satisfactory completion of start-up, verification of performance and the thirty (30) day test period described earlier. When the Contractor has satisfied himself as to proper system operation he shall advise the BAS Commissioning Consultant to establish a date for Final Acceptance. This will involve a random sampling of the point-by-point check of all hardware and software items including graphics and displayed data, as well as performing tasks as directed.
- .2 Supply 2-way radios and all test equipment as previously specified. Have on-site technical personnel capable of re-calibrating all field hardware and modifying software.
- .3 Test each system independently and then in unison with other related systems. Test weather sensitive systems twice- once near winter design conditions and again near summer design conditions.
- .4 Optimize operation and performance of each system. Test full scale emergency operation and integrity of smoke management and other life safety systems.
- .5 Demonstrate to the Consultant the operation of each system including sequence of operations in regular and emergency modes, under all normal and emergency conditions, start-up, shut-down, interlocks, and lock-outs.
- .6 Upon completion of the testing submit a point-by-point verification report to the Consultant to summarize all testing.

1.32 Documentation

- .1 Documentation shall consist of four (4) hard copies and one soft copy for all information described below
- .2 The final documentation package shall include:

- .1 Hard and soft copies of all control drawings.
  - .2 Flow charts.
  - .3 Manufacturer's technical data sheets for all hardware and software.
  - .4 Factory operating and maintenance manuals with any customization required.
  - .5 Soft copies of programming and front-end software and each controller's database. Hard copy output of programming is not necessary.
  - .6 Provide clear, concise, typewritten and soft copy descriptions of all control sequences in the working language.
  - .7 Soft copy text files shall be in WordPerfect or Microsoft Word.
- .3 Each instruction and reference manual shall be bound in hardback, 3 ring, binders or an approved equivalent shall be provided to the Consultant. Binders to be no more than 2/3 full. Each binder to contain index to full volume. One (1) complete set of manuals shall be furnished prior to the time that the system or equipment tests are performed, and the remaining manuals shall be furnished at acceptance. The identification of each manual's contents shall be inscribed on the cover and spine. The manuals shall include the names, addresses and telephone numbers of each subcontractor installing equipment systems and of the local representatives for each item of equipment and each system. The manuals shall have a table of contents and be assembled to conform to the table of contents with the tab sheets placed before instructions covering the subject. Additionally, each manual shall contain a comprehensive index of all manuals submitted in accordance with this paragraph. Manuals and specifications shall be furnished which provide full and complete coverage of the following subjects:

Operational Requirements: This document shall describe in concise terms, all the functional and operational requirements for the system and its functions that have been implemented. It shall be written using common terminology for building operation staff and shall not presume a knowledge of digital computers, electronics or in-depth control theory.

System Operation: Complete step by step procedures for operation of the system, including required actions at each operator station; operation of computer peripherals; input and output formats; and

emergency, alarm and failure recovery. Step-by-step instructions for system startup, back-up equipment operation, and execution of all system functions and operating modes shall be provided.

Maintenance: Documentation of all maintenance procedures for all system components including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective module. This shall include calibration, maintenance, and repair or replacement of all system hardware.

Test Procedures and Reports: The test implementation shall be recorded with a description of the test exercise script of events and documented as test procedures. A provision for the measurement or observation of results, based on the previously published test specification, forms the test reports. The procedures record and the results of these exercises shall be conveniently bound and documented together.

Configuration Control: Documentation of the basic system design and configuration with provisions and procedures for planning, implementing, and recording any hardware or software modifications required during the installation, test, and operating lifetime of the system. This shall include all information required to ensure necessary coordination of hardware and software changes, data link or message format/content changes, and sensor or control changes in the event system modification are required, and to fully document such new system configurations.

### 1.33 Training

- .1 The Contractor shall provide the services of competent instructors who will provide instruction to designated personnel in the adjustment, operation and maintenance, including pertinent safety requirements, of the equipment and system specified. The training shall be oriented towards the system installed rather than being a general "canned" training course.
- .2 Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The number of person-days (eight hours) of instruction furnished shall be as specified below as a minimum. A training manual shall be provided for each trainee which describes in detail the data included in each training program.

- .3 All equipment and material required for classroom training shall be provided by the contractor. A person-week shall be considered as 37.5 hours, 8:00 am to 12:00 noon, and 12:30 pm to 4:30 pm Monday through Friday.
- .4 The training program shall be accomplished in two (2) phases over a six (6) month period. The first phase shall be for a period of two (2) days prior to the thirty (30) day test period at a time mutually agreeable between the contractor and Consultant. Operating personnel will be trained in functional operations of the system installed and the procedures that the operators will employ for system operation. This phase shall be augmented with continuous on-the-job training during the thirty (30) days acceptance period. First Phase training shall include the following:
  - .1 General BAS architecture (overview).
  - .2 System communications (overview).
  - .3 Operation of computer and peripherals (overview).
  - .4 Operator interface functions for control of HVAC systems (detailed).
  - .5 Control descriptive logic (detailed for each system).
  - .6 Report generation (overview).
  - .7 Elementary preventive maintenance
- .5 The second phase of training shall be conducted eight (8) weeks after system acceptance for a period of five (5) days. Training will be provided for three categories of personnel - operators, equipment maintenance personnel and programmers. All classes may run with multiple instructors on a prearranged schedule. The training shall include as a minimum, but not be limited to:
  - .1 Operator Training: personnel including operators, equipment maintenance personnel and programmers, will be given a condensed version of Phase One training.
  - .2 Equipment Maintenance: personnel will be given a minimum of two (2) days training, within the five (5) days period specified, in the maintenance of BAS equipment. This training shall include:
    - .1 General equipment layout.
    - .2 Trouble shooting of all BAS equipment.
    - .3 Preventive maintenance of all BAS components.
    - .4 Sensors and controls maintenance and calibration.
  - .3 Programmers: personnel will be given a minimum of two (2) days training within the five (5) day period specified, on the following subjects:

- .1 System architecture (10%).
- .2 Application program (15%).
- .3 Color graphic generation (10%)
- .4 PCU programming (50%)
- .5 Troubleshooting and debugging (15%)

1.34 Warranty

- .1 Provide warranty certificates wherever given in excess of the normal warranty period showing the name of the firm giving the warranty, dated from the issuance of the Certificate of Substantial Performance and acknowledged on specific equipment and systems.
- .2 Include these certificates with the Operation and Maintenance Manual in the appropriate sections.
- .3 Contractor shall give a minimum one (1) year warranty for parts and labor on all equipment and materials installed and shall select materials and equipment where the Manufacturer gives the same warranty arrangements. Warranty shall commence on the date of the Consultant's issuance of the Certificate of Substantial Completion.
- .4 Provide an optional four (4) year extended warranty as indicated in the Instructions to Bidders.
- .5 The Contractor shall agree to make good at his own expense any equipment that fails to operate due to poor workmanship, manufacturing defect or improper installation. Any repairs shall be made at the convenience of the building owner during normal working hours, unless deemed an emergency.
- .6 Provide upgrades to all software or all panel firmware issued during the warranty period at no charge to Owner.

END OF SECTION



## PART 1 - GENERAL

### 1.1 General

- .1 Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.
- .2 The system shall consist of a network of operator workstations, Network Control Units (NCU's), Local Control Units (LCU's) and Terminal Control Units (TCU's) (VAV Box Controllers, Fan Coil Unit Controllers, etc.). All controllers for terminal units, air handling units (AHU) and Operator Workstations shall communicate and share data, utilizing only the BACnet IP communications protocols.
- .3 All control devices shall communicate by means of the ANSI/ASHRAE Standard 135-1995 (BACnet) protocol.
- .4 No gateways shall be used for communication with controllers installed under this specification section. Gateways may be used for communicating with existing systems or with systems installed under other sections.

### 1.2 Workstation/ NCU Panel Support

- .1 As a minimum, Operator Workstations shall support Point-to-Point (PTP) and Ethernet BACnet LAN types. They shall communicate directly via these BACnet LAN's as a native BACnet device. Network operator Workstations shall comply with the requirements of a BACnet conformance class 3 device and support all BACnet services necessary to provide the following BACnet functional groups:
  - .1 Clock Function
  - .2 Hand Held Workstation Functional Group
  - .3 Personal Computer Workstation Functional Group
  - .4 Files Functional Group
  - .5 Time Master Functional Group
- .2 All proprietary services if used in the system shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be provided for working with proprietary information.
- .3 Standard BACnet object types shall include as a minimum: Calender, Command, Device, Event Enrolment, File and Schedule object types. All proprietary object types if used in the system shall

be thoroughly documented and provided as part of the submittal data.

- .4 Operator workstations and NCU panels shall directly reside on a local area network such that communications may be executed directly between controllers, directly between workstations, and between controllers and workstation on a peer-to-peer basis.

### 1.3 Dynamic Data Access

- .1 All operator devices, either network resident or connected via gateways, shall have the ability to access all point status and application report data, or execute control functions for any and all other devices via the local area network. Access to data shall be based upon logical identification of building equipment.

### 1.4 General Network Design

- .1 Network design shall include the following provisions:
  - .1 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers and upload/download efficiency between network devices.
  - .2 Support of any combination of controllers and operator workstations directly connected to the local area network.
  - .3 Detection and accommodation of single or multiple failures of either workstations, controller panels and the network media. The network shall include provisions for automatically reconfiguring itself to allow all operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures.
  - .4 Message and alarm buffering to prevent information from being lost.
  - .5 Error detection, correction, and retransmission to guarantee data integrity.
  - .6 Default device definition to prevent loss of alarms or data, and ensure alarms are reported as quickly as possible in the event an operator device does not respond.
  - .7 Commonly available, multiple sourced, networking components shall be used to allow the system to coexist with other networking applications such as office automation.
  - .8 Synchronization of the real-time clocks in all NCU panels shall be provided.



1.5 System  
Documentation

- .1 For all system elements-Operator Workstations, global controllers, logic controllers, routers, repeaters, and converters; provide BACnet Protocol Implementation Conformance Statements (PICS) to cover the following:
  - .1 Product Description
  - .2 BACnet Conformance Class Supported
  - .3 BACnet Functional Groups Supported
  - .4 BACnet Standard Application Services Supported
  - .5 Standard Object Types Supported
  - .6 Data Link Layer Options
  - .7 Character Sets Supported
  - .8 Special Functionality
- .2 Provide complete description and documentation of any proprietary services and/or objects used in the system.

END OF SECTION



## PART 1 - GENERAL

### 1.1 General

- .1 Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.
- .2 Environmental Conditions: The OWS and its immediate associated devices shall be able to operate properly under environmental conditions of 10°C to 32°C and a relative humidity of 20 to 90% non-condensing.
- .3 General Description: The OWS shall consist of commercially available general purpose equipment manufactured by a recognized manufacturer with factory authorized service centres within 50 km of the job site. Computer clones shall not be acceptable. The OWS shall be provided for centralized system control, information management, alarm management and data base management functions. All real time control functions shall be resident in the standalone programmable controllers (PCUs and TCUs).
- .4 Provide the operator workstation where indicated on the drawings, or as coordinated during the shop drawing process.

## PART 2 - PRODUCTS

### 2.1 Computer

- .1 The computer processors and video card shall be suitable to support the system software.
- .2 The computer shall include the following features as a minimum requirement:
  - .1 24" LCD high resolution monitor.
  - .2 Two (2) button Optical Scroll Microsoft mouse.
  - .3 Spare expansion slots.
  - .4 Network card.
  - .5 Colour ink jet printer
- .3 Power supply unit shall accept 120V 60 Hz. source and shall include line surge and low voltage protection for the computer and its peripherals.

- 2.2 Power Supplies .1 Provide the OWS and each MCU with individual UPS to provide clean, reliable, noise-filtered power at all times and to protect and maintain systems operation throughout short term power interruptions of up to fifteen (15) minutes duration.
- 2.3 Control Desk Console .1 Provide a control desk to accommodate all the operator work station equipment specified and with spare room for the operators work space. The desk to be commercial grade steel office furniture suitable for computer and printer equipment.
- .2 Provide swivel ergonomically designed upholstered chair with arms and castors.
- 2.4 Portable Operators Terminal .1 Provide one portable operators terminal (POT) complete with the front end software installed to allow full use as either a front end or a terminal. If two software locks are required to permit use as a front end system, these shall be supplied.
- .2 The POT shall allow communication with the by direct connection to the DDC system panel network and through web access.
- .3 The POT shall be an IBM (or other recognized manufacturer) portable notebook computer suitable to support the software.
- .4 Provide the necessary software and network connector to allow the POT to connect to the network at each MCU. All functionality of the front end OWS shall be available through the POT.
- 2.5 Programming Software .1 The Operator's terminal shall include programming tools for all controllers supplied. All controllers shall be programmed using graphical tools that allow the user to connect function blocks on screen that provide sequencing of all control logic. Function blocks shall be represented by graphical displays that are easily identified and distinct from different types of blocks. Graphical programming that uses simple rectangles and squares is not acceptable.

- .2 The user shall be able to pick a graphical function block from the menu and place on the screen. Programming tools shall place lines connecting appropriate function blocks together automatically. Provide zoom in and zoom out capabilities. Function blocks shall be downloaded to controller without any reentry of data.
- .3 The programming tools shall include a test mode. Test mode shall show user real-time data on top of graphical display of selected function blocks. Data shall be updated real-time with no interaction by the user. Function blocks shall be animated to show status of data inputs and outputs. Animation shall show change of status on logic devices and countdown of timer devices in graphical format.

## 2.6 Operating System

- .1 Operator's workstation software shall be Microsoft Windows based. Software shall be multi-tasking, capable of executing and displaying multiple functions in individual windows while running concurrently with other Windows programs such as word processors or database programs. Software shall support Windows Dynamic Data Exchange (DDE) interface. Software shall strictly follow Microsoft Windows API guidelines. Systems using proprietary software or operating systems other than that described above are strictly prohibited. Operation of the terminal software shall be simple and intuitive.
- .2 Operator's workstation software shall contain an easy-to-operate system allowing configuration of system-wide controllers, including management and display of the controller programming. This system shall provide the capability to configure controller binary and analog inputs/outputs.
- .3 The system shall be capable of utilizing third-party Windows-based programs for such things as spreadsheet analysis, graphing, charting, custom report generation, and graphics design packages. Graphics generation shall be done using standard Windows packages. No proprietary graphics generation software shall be needed.
- .4 The main operator's workstation shall be equipped to act as a system server. This system server shall store copies of loadable software for all field components and shall be capable of automatic or manual reloading of such software into the field components as

required. The system server shall also gather and archive system operating data, such as trendlogs, energy logs, and other historical operating data.

## 2.7 Operator's Control Software

- .1 Provide software which enables the non programmer operator to easily perform tasks which are likely to be part of his daily routine.
- .2 The operator's console shall provide facilities for manual entries and visual displays enabling an operator to enter information into the system and obtain displays and logs of system information. All requests for status, analog, graphic displays, logs, and control shall be selected from the operator's console. The operator interface shall minimize the use of typewriter style keyboard by implementing a mouse or similar pointing device and "point and click" approach to command selection. The facility shall be provided to permit the operator to perform the following tasks:
  - .1 Automatic logging of digital alarms and change of status message.
  - .2 Automatic logging of all analog alarms.
  - .3 System changes (alarm limits, set-points, alarm lock-outs, etc.).
  - .4 Display specific points as requested by the operator.
  - .5 Provide reports as requested by the operator and on scheduled basis where so required.
  - .6 Display graphics as requested by the operator.
  - .7 Display help information.
  - .8 Provide trend logs as required by the operator.
  - .9 Provide manual control of digital and analog outputs as required by the operator.
  - .10 Direct the hard copy output of information to the device selected by the operator.
  - .11 Data displayed on monitor to cyclic update as appropriate.
  - .12 Online changes:
    - .1 Alarm limits.
    - .2 Setpoints.
    - .3 Deadbands.
    - .4 Changes/deletions/additions of points.
    - .5 Control and change of state changes.
    - .6 Time of day, day, month, year.
    - .7 Control loop control description changes for PCU.
    - .8 Control loop tuning changes.
    - .9 Schedule changes.

- .10 Changes/additions/deletions to system graphics.
- .11 Changes/additions/deletions to total systems.

- .3 It shall be possible for the OWS operator to initiate analog and digital output commands. Where these outputs are normally originated by the BAS software, the provision shall exist for the operator to terminate automatic BAS control of any particular output and to originate a manual analog or digital output command. The provision shall exist for the operator to return analog or digital output command functions to automatic BAS software control.
- .4 It shall be possible for the OWS operator to place any computed system setpoint to a computed basis as and when required.
- .5 All above functions shall operate under the password protection system.
- .6 A vocabulary of at least twenty-five (25) different descriptions using at least six alphanumeric characters to identify engineering units for analog input and output points. Typical description are as follows: %, °C, KPA, KW, KWH, L/S, CFM, °F, PSI. The descriptions shall be alterable from the OWS console with the system on-line.
- .7 Upon operator's request, the system shall present the condition of any single point, any system, and area or the whole system. Analog values and status shall be updated whenever new values are received. Points in alarm shall be flagged by blinking, inverse video different colour, bracketed, or by some other means to differentiate them from points not in alarm.

## 2.8 Error Messages

- .1 Inform operator of all errors in data, errors in entry instructions, failure of equipment to respond to requests or commands, or failure of communications between components of the BAS.
- .2 Error messages to be comprehensive and communicate clearly to operator precise nature of problem.

## 2.9 Password Protection

- .1 Provide security system that prevents unauthorized use unless operator is logged on. Access shall be limited to operator's

terminal functions unless user is logged on. This includes displays as outlined above.

- .2 Each operators workstation shall provide security for one-hundred (100) users minimum. Each user shall have an individual User ID, User Name and Password. Entries are alphanumeric characters only and are case sensitive (except for User ID). User ID shall be 0–8 characters, User Name shall be 0–29 characters, and Password shall be 4–8 characters long. Each system user shall be allowed individual assignment of only those control functions and menu items to which that user requires access. All passwords, user names, and access assignments shall be adjustable online at the operator's terminal. Each user shall also have a set security level, which defines access to displays and individual objects the user may control. System shall include ten (10) separate and distinct security levels for assignment to users.

## 2.10 Trend Data

- .1 System shall periodically gather historically recorded selected samples of object data stored in the field equipment (global controllers, field controllers) and archive the information on the operator's workstation (server) hard disk. Archived files shall be appended with new sample data, allowing samples to be accumulated over several years. Systems that write over archived data shall not be allowed, unless limited file size is specified. Samples may be viewed at the operator's terminal in a trendlog. Logged data shall be stored in spreadsheet format. Operator shall be able to scroll through all trendlog data. System shall automatically open archive files as needed to display archived data when operator scrolls through the data vertically. All trendlog information shall be displayed in standard engineering units.
- .2 Software shall be included that is capable of graphing the trend logged object data. Software shall be capable of creating two-axis (x,y) graphs that display up to six object types at the same time in different colors. Graphs shall show object type value relative to time.
- .3 Operator shall be able to change trend log setup information as well. This includes the information to be logged as well as the interval at which it is to be logged. All input, output, and value object types in the system may be logged. All operations shall be password protected. Setup and viewing may be accessed directly from any and all graphics object is displayed on.



- .4 System shall be capable of periodically gathering energy log data stored in the field equipment and archive the information on the operator workstation's hard disk. Archive files shall be appended with the new data, allowing data to be accumulated over several years. Systems that write over archived data shall not be allowed unless limited file size is specified. System shall automatically open archive files as needed to display archived data when operator scrolls through the data. Display all energy log information in standard engineering units.
- .5 System software shall be provided that is capable of graphing the energy log data. Software shall be capable of creating two-axis (x,y) graph that show recorded data, relative to time. All data shall be stored in comma-delimited file format for direct use by third-party spreadsheet or other database programs. Operation of system shall not be affected by this operation. In other words, it shall stay completely online.
- .6 Operator shall be able to change the energy log setup information as well. This includes the meters to be logged, meter pulse value, and the type of energy units to be logged. All meters monitored by the system may be logged. All operations shall be password protected.

#### 2.11 Graphics

- .1 The operator's workstation shall display all data associated with the project. The operator's terminal software shall accept Windows BITMAP (\*.bmp) format graphic files for display purposes. Graphic files shall be created using scanned, full color photographs of system installation, AutoCAD drawing files of field installation drawings and wiring diagrams from as-built drawings. Operator's terminal shall display all data using 3-D graphic representations of all mechanical equipment.
- .2 System shall be capable of displaying graphic file, text, and dynamic object data together on each display. Information shall be labeled with descriptors and shall be shown with the appropriate engineering units. All information on any display shall be dynamically updated without any action by the user. Terminal shall allow user to change all field-resident BAS functions associated with the project, such as setpoints, weekly schedules, exception schedules, etc. from any screen no matter if that screen shows all text or a complete graphic display. This shall be done without any

reference to object addresses or other numeric/mnemonic indications.

- .3 All displays shall be generated and customized in such a manner by the local DDC system supplier that they fit the project as specified. Canned displays shall not be acceptable. Displays shall use standard English for labeling and readout. Systems requiring factory programming for graphics or DDC logic are specifically prohibited. All graphics and DDC programming shall be supported locally by the installing contractor without factory dependency or assistance.
- .4 Binary objects shall be displayed as ON/OFF/NULL or with customized text. Text shall be justified left, right or center as selected by the user. Also, allow binary objects to be displayed as individual change-of-state bitmap objects on the display screen such that they overlay the system graphic. Each binary object displayed in this manner shall be assigned up to three bitmap files for display when the point is ON, OFF or in alarm. For binary outputs, toggle the object's commanded status when the bitmap is selected with the system digitizer (mouse). Similarly, allow the terminal operator to toggle the object's status by selecting (with the mouse) a picture of a switch or light, for example, which then displays a different picture (such as an "ON" switch or lighted lamp). Additionally, allow binary objects to be displayed as an animated graphic.
- .5 Animated graphic objects shall be displayed as a sequence of multiple bitmaps to simulate motion. For example: when a pump is in the OFF condition, display a stationary picture of the pump. When the operator selects the pump picture with the mouse, the represented object's status is toggled and the picture of the pump's impeller rotates in a time-based animation. The operator shall be able to click on an animated graphical object or switch it from the OFF position to ON, or ON to OFF. Allow operator to change bitmap file assignment and also create new and original bitmaps online. System shall be supplied with a library of standard bitmaps, which may be used unaltered or modified by the operator. Systems that do not allow customization or creation of new bitmap objects by the operator (or with third-party software) shall not be allowed.
- .6 Analog objects shall be displayed with operator modifiable units. Analog input objects may also be displayed as individual bitmap items on the display screen as an overlay to the system graphic.

Each analog input object may be assigned to a minimum of five bitmap files, each with high/low limits for automatic selection and display of the bitmaps. As an example, a graphic representation of a thermometer would rise and fall in response to either the room temperature or its deviation from the controlling setpoint. Analog output objects, when selected with the mouse, shall be displayed as a prompted dialog (text only) box. Selection for display type shall be individual for each object. Analog object values may be changed by selecting either the "increase" or "decrease" arrow in the analog object spinner box without using the keypad. Pressing the button on the right side of the analog object spinner box allows direct entry of an analog value and accesses various menus where the analog value may be used, such as trendlogs.

- .7 Analog objects may also be assigned to an area of a system graphic, where the color of the defined area would change based on the analog object's value. For example, an area of a floor-plan graphic served by a single control zone would change color with respect to the temperature of the zone or its deviation from setpoint. All editing and area assignment shall be created or modified online using simple icon tools.
- .8 A customized menu label (push-button) shall be used for display selection. Menu items on a display shall allow penetration to lower level displays or additional menus. Dynamic point information and menu label push buttons may be mixed on the same display to allow sub-displays to exist for each item. Each display may be protected from viewing unless operator has appropriate security level. A separate security level may be assigned to each display and system object.
- .9 A mouse shall be used to move the pointer arrow to the desired item for selection of new display or to allow the operator to make changes to object data.
- .10 Displays may be modified on site or via remote communications.
- .11 Entire system shall operate without dependency on the operator's terminal.

## 2.12 Alarms

- .1 Operator's terminal shall provide audible, visual, and printed means of alarm indication. The alarm dialog box shall always become the top dialog box regardless of the application(s), currently running

(such as a word processor). Printout of alarms shall be sent to the assigned terminal and port.

- .2 System shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the system operator's terminal. Each entry shall include a description of the event-initiating object generating the alarm, time and date of alarm occurrence, time and date of object state return to normal, and time and date of alarm acknowledgment.
- .3 Alarm messages shall be in user-definable text English or other specified language) and shall be entered either at the operator's terminal or via remote communication.

#### 2.13 Scheduling

- .1 Operator's terminal display of weekly schedules shall show all information in easy-to-read seven (7) day (weekly) format for each schedule. This includes all ON/OFF times (to the minute) for each day's events.
- .2 Exception schedules (non-normal schedules, such as holidays or special events) shall display all dates that are an exception to the weekly schedules. These specialty schedules shall be displayed at the operator's terminal in a format similar to the weekly schedules, again allowing easy data entry. Exception schedule data is entered by the following methods: date entries (one day entries), date-to-date (a range or span of days), and by weekday (for example, a given day of a given week each month). User shall be able to scroll easily through the months for each year as a minimum.
- .3 At the operator's terminal, the system user shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate security access.

#### 2.14 Archiving

- .1 Store back-up copies of all controller data bases in at least one OWS.
- .2 Provide continuous supervision of integrity of all controller data bases. If controller loses data base, system to automatically download new copy of data base to restore proper operation.

- .3 Data base back-up and downloading to occur over LAN without operator intervention. Operator to be able to manually download entire controller data base or parts thereof.

## 2.15 Reports

- .1 Provide a report facility to generate and format for display, printing, or permanent storage, as selected by the operator, the reports as specified in this section. If display output is requested, it shall be scrollable; scroll bars will be used to allow easy and flexible movement within the report. Output to be sorted by area, system point.
- .2 Periodic/Automatic Report: Provide the software to automatically generate any report specified, the user will be able to specify the type of report, start time and date, interval between reports (hourly, daily, weekly, monthly) and output device. The software will allow the operator to modify the periodic/automatic reporting profile at any time.
- .3 The software to provide for the following report types:
  - .1 Dynamic Reports: provide software to allow operator to request a display of the dynamic value for the user specified points which shall indicate the status at the time the request was entered and updated at an operator modifiable scan frequency. It will be possible to select points on the following basis:
    - .1 All points in all areas.
    - .2 Area (all points in area).
    - .3 Area system (all points in system).
    - .4 Area system point (individual point).
    - .5 System (all points by system and point type).
    - .6 System point (all points by system and point type).
    - .7 Area point (all points by area and point type).
  - .2 Summary Report: Provide the software to permit the display or printing the dynamic value for the user specified points. Reports to be available on same basis as dynamic reports. Output will be to the user selected output device.
  - .3 Trend Reports: Provide software to permit the trending of points selected by the operator, including as a minimum digital input and output, analog input and output, set points, and calculated values.
  - .4 Historical Data Collection: All trend data is also collected historically. Provision will be provided to ensure historical

data is not lost. The ability to off-load historical data to removable media, and to later load data previously backed-up, will be provided. Historical data values, for an operator specified time range and for operator specified points, may be output the same as for trend data.

- .5 Critical Alarm Summary: A summary of those points in the critical alarm state and to include as minimum, point acronym, point description, alarm type, limit exceed, current value, alarm type, time and date of occurrence.
- .6 Maintenance Alarm Summary: A summary of those points in maintenance alarm and to include as a minimum, point acronym, point description, current value, alarm type, limit exceed, time and date of occurrence.
- .7 Alarm Summary: A summary of all points in alarm and to include as a minimum, point acronym, point description, current value, alarm type, limit exceeded, and time and date of occurrence.
- .8 Disable Point Summary: A summary of all points in the disabled state and to include as a minimum point acronym and point description.
- .9 Run Time Summary: A summary of the accumulated running time of selected pieces of equipment with point acronym and description, run time to date, alarm limit setting. The run time shall continue to accumulate until reset individually by means of suitable operator selection.
- .10 Schedule Summary: A summary of all schedules and to include as a minimum, which days are holidays and, for each section, the day of the week, the schedule times and associated values; for digital schedules value will be on or off; for analog schedules value will be an analog value.
- .11 User Record Summary: A summary of all user records to include as a minimum, user name, pass-word, initials, command access level and point groups assigned.

## 2.16 Utility Software

- .1 Software shall allow the building operator to access and manipulate the control schematic diagrams.

### PART 3 - EXECUTION

#### 3.1 Installation Requirements

- .1 Provide all necessary power as required from local 120 volt emergency power branch circuit panels for the operator's work station, controllers, and applicable terminal devices. Install tamper locks on breakers of circuit panels. See also UPS requirements.

END OF SECTION





## PART 1 - GENERAL

### 1.1 General

- .1 Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.
- .2 Environmental Condition: The PC's and immediate associated devices shall be able to operate properly under environmental conditions of 0°C to 50°C and a relative humidity of 10 to 95% non-condensing. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -40°C to 50°C.
- .3 All controllers shall be in Nema boxes, installed within the ceiling space.

### 1.2 System Design

- .1 The system shall use the BACnet IP protocol for communication at all levels.

### 1.3 Surge and Transient Protection

- .1 Isolation shall be provided at all network terminations as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standard 587-1980.

### 1.4 Powerfail Restart

- .1 In the event of the loss of normal power, there shall be an orderly shutdown of all controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all controller configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of thirty (30) hours.
- .2 Upon restoration of normal power, the controller shall automatically resume full operation without manual intervention.
- .3 Controller memory shall not be lost during a power failure.
- .4 The user shall have the capability of loading or re-loading all software via the OWS or the local terminal port.

1.5 Installation  
Requirements

- .1 Provide all necessary power as required from the local 120V branch circuit panelboard for all controller equipment including the processor, terminal device controllers and applicable field interface devices.
- .2 Controllers to be installed in lockable enclosures.
- .3 Controllers required for the life safety system operation shall be powered from the emergency power system.

PART 2 - PRODUCTS

2.1 Network Control  
Unit, NCU

- .1 The Network Control Units (NCU) shall be microprocessor-based. They shall also be multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers & power supplies. Controller size shall be sufficient to fully meet the requirements of this specification and project requirements.
- .2 Each NCU shall have sufficient memory to support its operating system and databases, including:
  - .1 Control processes.
  - .2 Energy management applications.
  - .3 Alarm management applications including custom alarm messages for each level alarm for each point in the system.
  - .4 Historical/trend data for points specified.
  - .5 Maintenance support applications.
  - .6 Custom processes.
  - .7 Operator I/O.
  - .8 Manual override monitoring.
- .3 Each NCU shall have a minimum of 20% spare capacity for future.
- .4 Provide sufficient internal memory for the specified control sequences and have at least 25% of the memory available for future use.
- .5 The NCU shall provide serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, and portable laptop operator's terminals. The NCU shall allow temporary use of portable devices

without interrupting the normal operation of permanently connected modems, printers or terminals.

- .6 The NCU shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
- .7 Should the NCU memory be lost for any reason, the user shall have the capability of reloading the controller software via the local port, or from a network workstation PC.

## 2.2 Local Control Units

- .1 The Local Control Units (LCU) shall be microprocessor-based. They shall also be multi-tasking, realtime digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point list.
- .2 Each LCU shall have sufficient memory, to support its own operating system and databases, including:
  - .1 Control processes.
  - .2 Energy management applications.
  - .3 Alarm management applications.
  - .4 Historical/trend data for points specified.
  - .5 Maintenance support applications.
  - .6 Custom processes.
  - .7 Manual override monitoring.
- .3 Each LCU shall support:
  - .1 Monitoring of the following types of inputs, without the addition of equipment outside the DDC Controller cabinet:
    - .1 Analog inputs of 4-20 mA, 0-10 Vdc, thermistors or 1000 ohm RTD's.
    - .2 Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
  - .2 Each LCU shall be capable of providing the following control outputs without the addition of equipment outside the DDC controller cabinet.
    - .1 Digital outputs (contact closure for motor starters up to size 4).
    - .2 Analog outputs of 4-20 mA or 0-10 Vdc.

- .4 Each LCU shall have a minimum of 20% spare capacity of future point connection. The type of spares shall be in the same proportion as the implemented I/O functions of the panel, but in no case shall there be less than two (2) spares of each implemented I/O type. Provide all processors, power supplies and communication controllers complete so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.
- .5 Provide sufficient internal memory for the specified control sequences and have at least 25% of the memory available for future use.
- .6 The LCU shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LED's or analog indication of value shall also be provided for each analog output. Status indication shall be visible without opening the panel door.
- .7 The LCU shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
- .8 Should the LCU memory be lost for any reason, the user shall have the capability of reloading the controller software via the local port, or from a network workstation PC.

### 2.3 Portable

#### Operator's Terminal

- .1 Functionality of the portable operator's terminal connected at any MCU controller:
  - .1 Access all DDC controllers on the network.
  - .2 Backup and/or restore DDC controller data bases for all system panels, not just the DDC controller connected to.
  - .3 Display all point, selected point and alarm point summaries.
  - .4 Display trending and totalization information.
  - .5 Add, modify and/or delete any existing or new system point.
  - .6 Command, change setpoint, enable/disable any system point.
  - .7 Program and load custom control sequences as well as standard energy management programs.

- .2 Functionality of the portable operator's terminal connected to any Local Control Unit:
  - .1 Provide connection capability at either the ASC or a related room sensor to access controller information.
  - .2 Provide status, setup and control reports.
  - .3 Modify, select and store controller data base.
  - .4 Command, change setpoint, enable/disable any controller point.
- .3 The same portable operator's terminal shall be used for both the NCU's and LCU's.
- .4 Connection of a POT to a distributed control processor shall not interrupt nor interfere with normal network operation in any way, prevent alarms from being transmitted or preclude centrally-initiated commands and system modification.

#### 2.4 Terminal Control Units

- .1 Provide Terminal Control Units (TCU) for control of each piece of terminal equipment.
- .2 Controllers shall include all point inputs and outputs necessary to perform the specific control sequences. As a minimum, 50% of the point outputs shall be of the universal type; that is, the outputs may be utilized either as modulating or two-state, allowing for additional system flexibility. Analog outputs shall be industry standard signals such as 24V floating control, allowing for interface to a variety of modulating actuators.
- .3 Each controller performing space temperature control shall be provided with a matching room temperature sensor. Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the controller. In lieu of an internal jack, provide a separate terminal jack mounted on a stainless steel wall plate adjacent to the sensor to facilitate direct access to the controller via the terminal.
- .4 Each room sensor shall also include the following auxiliary devices:
  - .1 Setpoint Adjustment: The setpoint adjustment dial shall allow for modification of the temperature by the occupant. Setpoint adjustment may be locked out, overridden or limited

as to time or temperature through software by an authorized operator at the central workstation, DDC controller, or via the portable operator's terminal. In lieu of an integral adjustment dial, provide a separate dial mounted on a stainless steel wall plate adjacent to the sensor to perform the specified functionality.

.2 Temperature Indicator: None required.

.3 Override Switch: An override switch or push-button shall initiate override of the night setback mode to normal (day) operation when activated by the occupant. The override function may be locked out, overridden or limited as to the time through software by an authorized operator at the central workstation, DDC controller or via the portable operator's terminal.

.5 Each controller shall perform its primary control function independent of other NCU controller LAN communication, or if LAN communication is interrupted. Reversion to a fail-safe mode of operation during LAN interruption is not acceptable. The controller shall receive its real-time data from the NCU controller time clock to insure LAN continuity. Each controller shall include algorithms incorporating proportional, integral, and derivative (PID) gains for all applications. All PID gains and biases shall be field-adjustable by the user via terminals as specified herein. This functionality shall allow for tighter control of space conditions and shall facilitate optimal occupant comfort and energy savings.

.6 Provide each TCU with sufficient memory to accommodate point databases, operating programs, local alarming and local trending. All databases and programs shall be stored in non-volatile EEPROM, EPROM and PROM. The controllers shall be able to return to full normal operation without user intervention after a power failure of unlimited duration. Operating programs shall be field selectable for specific applications. In addition, specific applications may be modified to meet the user's exact control strategy requirements, allowing for additional system flexibility. Controllers that require factory changes of all applications are not acceptable.

.7 Controllers shall be powered from a 24 VAC source and shall function normally under an operating range of 18 to 28 VAC (-25% to +17%), allowing for power source fluctuations and voltage drops. The BAS contractor shall provide a dedicated power source and separate isolation transformer for each controller unable to function

normally under the specified operating range. The controllers shall also function normally under ambient conditions of 32°F to 122°F (0°C to 50°C) and 10% to 95% RH (non-condensing). Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.

- .8 Each controller shall include provisions for manual and automatic calibration of the differential pressure transducer in order to maintain stable control and insuring against over time. Calibration shall be accomplished by stroking the terminal unit damper actuator to a 0% position so that a 0 cfm air volume reading is sensed. The controller shall automatically accomplish this whenever the system mode switches from occupied to unoccupied or vice versa. Manual calibration may be accomplished by either commanding the actuator to 0% via the POT or by depressing the room sensor override switch. Calibration of the transducer at the controller location shall not be necessary.
- .9 Controller shall interface to a matching room temperature sensor as previously specified. The controller shall function to maintain space temperature to within  $\pm 1.5^{\circ}\text{F}$  ( $0.9^{\circ}\text{C}$ ) of setpoint at the room sensor location. Each controller shall also incorporate an algorithm that allows for resetting of the associated air handling unit discharge temperature if required to satisfy space requirements. This algorithm shall function to signal the respective DDC controller to perform the required discharge temperature reset in order to maintain space temperature setpoint.
- .10 It shall be possible to view and reset the space temperature, temperature setpoint, maximum airflow setting, minimum airflow setting, and actual airflow, at the OWS.

### PART 3 - CONTROLLER SOFTWARE

#### 3.1 General Requirement

- .1 Software shall include but not be limited to definitions and operating systems executive, communications, application programs, operator interface, and control description logic.

- .2 Software to include any "firmware" or instructions which are programmed into ROM or other non-volatile memory.
- .3 The overall design philosophy of software with special emphasis on operator interfacing must use management by exception philosophy, i.e. report abnormalities by order of event occurrences.
- .4 All initial programming of all controllers shall be done by this contractor.

### 3.2 Energy Management Software

- .1 The following energy management capabilities shall be furnished standard as part of the BAS.
- .2 Scheduling: The scheduling program shall have a minimum of thirty-two (32) named master schedules. Each master schedule shall have a minimum of eight (8) day schedules (7 plus holiday). To these master schedules, a minimum of twenty-four (24) system loads (HVAC equipment, etc.) or groups of loads can be assigned. The master schedule shall be individually editable for each day of the week and holiday. On any day, a minimum of six (6) time of day events may be edited, including:
- .3 Optimum Start/Stop: an optimum start/stop program shall determine the required equipment start/stop timing by applying inside/outside temperature information to the user's time of day schedule. The optimum start/stop program shall run independently for each controlled load or zone. The program shall automatically make adjustments to itself based on historical data.
- .4 Duty Cycling: The duty cycle program shall cycle a minimum of thirty-two (32) pieces of equipment according to user defined on/off patterns. User editable parameters are to include period length, off time and delay time. Program shall incorporate temperature and humidity overrides to ensure that indoor air quality and occupant comfort are not compromised.
- .5 Demand Limiting: The demand limiting program shall monitor building power consumption from signals generated by a pulse generator (provided by other) mounted at the building power meter or from a watts transducer or current transformer attached to the building feeder lines. The demand limiting program shall be based



on a predictive sliding window algorithm. The program shall be self-adjusting and shall control a minimum of two (2) independent demand limiting applications. Demand limiting parameters shall include fifteen (15) or thirty (30) minute intervals, shed/restore dead band width as well as maximum off time and temperature limits for each load to ensure that indoor air quality and occupant comfort are not compromised. Demand limiting within the VAV system shall be accomplished by resetting individual VAV box setpoints to reduce load while maintaining indoor air quality and comfort control in the space. The HVAC equipment shall be protected by the anti-recycle timer. Input capability shall also be provided for an end-of-billing period indication.

### 3.3 Building Management Software

- .1 The following building management capabilities shall be furnished as part of the BAS.
- .2 Timed Override: A timed override program shall be provided to enable the building operator to set up devices or groups of devices to be temporarily turned on for a defined period of time based on binary inputs, analog inputs, or CRT inputs. The override time shall be adjustable from 1 to 720 minutes. A standard weekly and monthly report shall be provided for easy documentation of timed override operation.
- .3 Direct Digital Control: The DDC program shall allow modulating control of remote devices based on sensed data. Standard control strategies shall include proportional, proportional plus integral, and proportional plus integral plus derivative control. Control routines shall be flexible enough to allow operator to set parameters and make adjustments. DDC loop setup and modifications shall be done through pre-formatted edit screens, with parameters listed in English language. Program shall include a dynamic graphic display printout routine to indicate the status and real time performance of the control loop.

As an alternative, auto tuning loops or another method of testing and proving control loop response may be provided.
- .4 Graphical Programming Language: A graphical programming language that allows non-programmers to build a picture of their control strategy using predefined logical operators, live devices and other control blocks on what is called a page. Programming should

consist of simply adding blocks, defining information in those blocks and attaching lines from block to block to make up a highly advanced and fully functional program.

- .5 Totalizing: A totalizing program shall be provided to enable the building operator to monitor and totalize any user-defined flow such as water flow, electricity, natural gas, steam and air. A minimum of 64 totalizing equations shall be provided.
- .6 Run Time Maintenance: The system shall monitor equipment status and generate maintenance messages based upon user designated run time, starts and/or calendar date limits. A minimum of thirty-two (32) separate devices shall be monitored under this function.
- .7 Expanded Messages: The user shall be able to define a minimum of ten forty (40) character messages for automatic printing in the event of system alarm and/or run time and maintenance events.
- .8 Reports and Logs: The system shall include the capability to store, review and print the following reports and logs. In addition these reports shall be saved to diskette as an ASCII file for use by other owner furnished software packages.
  - .1 Current Summary Report - An instantaneous summary of building status including heating and cooling degree days, on and off peak electrical demand performance, current electrical kWh consumption, and summary for critical temperature sensors listing today's minimum and maximum values.
  - .2 Monthly Summary Report - At end of the month summary of building status including heating and cooling degree days, on and off peak electrical demand performance, current electrical kWh consumption, and summary for critical temperature sensors listing this month's minimum and maximum values.
  - .3 Monthly Demand Limiting Report - A report for logging the electrical demand performance (both on and off peak) and the kWh consumption for each of the two utility meter programs shall be provided to the building operator. Included shall be the times of today's and yesterday's demand peaks as well as the time and date of the monthly demand peaks. This report shall log electrical performance for the present day and previous thirty-two (32) days.
  - .4 Yearly Demand Limiting Report - A report for logging the electrical demand performance (both on and off peak) and

- kWh consumption for each of the two utility meter programs. This report shall log electrical performance for the present month and previous twelve (12) months.
- .5 Yearly Meter Report - A report for logging the electrical kWh consumption for up to six (6) submeters. This report shall log electrical performance for the present month and previous twelve (12) months.
  - .6 Yearly Degree Day Report - A current month and previous twelve (12) month summary of heating and cooling degree days.
  - .7 Weekly Temperature Report - A previous seven (7) day summary of the minimum and maximum temperatures for the critical zone temperature sensors.
  - .8 Weekly Override Time Report - A previous seven (7) day summary
  - .9 of after hours override usage (in hours and minutes) for the
  - .10 timed override groups.
  - .11 Monthly override Time Report - A current and previous
  - .12 month summary of after hours override usage (in hours and
  - .13 minutes) for the timed override groups.
  - .14 Trend Logs - A custom report generator allowing the user to trend and store at least twenty-four (24) sample points based on a user-defined schedule.
  - .15 Event Logs - The system shall track system events including alarms, log-ons and diagnostics.
  - .16 Input/Output Status Reports - This reporting tool shall allow the operator to review the status of all system points.
  - .17 HVAC Equipment Reports - Reports shall be provided which indicate the HVAC equipment status as well as the status of all input/output points of connected HVAC equipment.
  - .18 Custom Report Capability - The building operator shall be provided with a simple method of creating custom reports.
- .9 Anti-Recycle Timer Protection: A software program shall be provided to allow each individual piece of HVAC equipment to be individually programmable with "minimum on", and "minimum off" timers to protect HVAC equipment from rapid cycling due to system or operator error. Minimum on/off timer program shall have priority over all application software functions except fire shutdown and smoke evacuation modes. For system start-up purposes. Timers shall be set at fifteen (15) minutes of an acceptable time as documented by the HVAC equipment supplier. Timers shall be individually programmable from 0-120 minutes.

- .10 Diagnostics: The building operator shall be provided with a report containing common symptom and diagnostic trouble shooting guides for HVAC system equipment. Compile and enter equipment symptom and diagnosis information from manufacturer's operations and maintenance manuals. When an equipment alarm is received, allow printing of report to assist personnel in troubleshooting. A system self-test shall be provided. On self-test initiation, panels failing to respond shall be identified on the printer.
- .11 Alarm Management: Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC controller shall perform distributed independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the DDC controller's ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.
- .1 All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
- .2 The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, DDC controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.
- .3 Alarm reports and messages will be directed to a user-defined list of operator devices or PC's.
- .4 In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a two-hundred (200) character alarm message to more fully describe the alarm condition or direct operator response.
- .1 Each DDC controller shall be capable of storing a library of at least fifty (50) alarm messages. Each message may be assignable to any number of points in the controller.
- .5 In dial-up applications, operator selected alarms shall initiate a call to a remote operator device.
- .12 Trending:

- .1 A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for points as specified in the I/O summary. DDC controllers shall store point history data for selected analog and digital inputs and outputs. Any point, physical or calculated, may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC controllers point group. Two methods of collection shall be allowed, either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of one (1) minute to seven (7) days shall be provided. Each DDC controller shall have a dedicated RAM based buffer for trend data and shall be capable of storing a minimum of 25,000 data samples.
  - .2 Trend data shall be stored at the DDC controllers and uploaded to the workstation when retrieval is desired. Uploads shall occur based upon either user-defined interval, manual command, or when the trend buffers are full. All trend data shall be available for use in third party personal computer applications.
  - .3 Continuous Point Histories: The Point History routine shall continuously and automatically sample the value of all analog inputs at half hour intervals. Samples for all points shall be stored for the past twenty-four (24) hours to allow the user to immediately analyze equipment performance and all problem-related events for the past day. Point History Files for binary input or output points and analog output points shall include a continuous record of the last ten status changes or commands for each point.
- .13 Custom Programming Requirements: A user-friendly custom DDC programming utility shall be provided to allow the building operator to tailor the system to meet individual needs and respond to changing building requirements. The building operator shall be able to create custom DDC routines using analog and binary point values, alarm states, constants, and shared variables to perform calculations.

The results of these calculations shall be used to perform analog control, binary control, DDC loop enable/disable, and other control functions. The building operator shall be able to download these routines to the system or custom application controllers either via modem, direct connect, or through a portable operator interface.

Custom routines in distributed controllers shall be maintained in non-volatile memory to prevent loss in a power outage.

Custom routines hosted in PCU's may use battery backup so long as a quick method of system downloading is provided.

END OF SECTION

## PART 1 - GENERAL

- |                                 |    |  |
|---------------------------------|----|--|
| <u>1.1 General</u>              | .1 | Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.  |
| <u>1.2 General Requirements</u> | .1 | Provide all remote sensing points and instrumentation as required for the complete BAS. All sensors shall have accuracies as stated hereinafter. Hysteresis, relaxation time, span, maximum/minimum limits, etc. shall also be accounted for in all application of sensors and controls. |
|                                 | .2 | All external trim material shall be completely corrosion resistant with all internal parts assembled in watertight, shockproof, vibration proof, heat resistant assembly.  |
|                                 | .3 | Use standard conduit box termination with slot screwdriver compression connector block unless otherwise specifically stated.   |
|                                 | .4 | Operating conditions 0° to 32°C with 10-90% RH (non-condensing unless otherwise specifically stated).  |
|                                 | .5 | Manufacturers installation instructions shall be supplied for all equipment supplied. All equipment shall be installed in accordance with manufacturers recommended methods and procedures.  |

## PART 2 - PRODUCTS

- |   |    |   |
|---|----|---|
| <u>2.1 CO<sub>2</sub> Sensor/<br/>Transmitter</u> | .1 | Shall have either NDIR or IRPA sensors suitable for operation in humidities from 5-95% RH and 0°C to +40° C temperatures, in a suitable enclosure for duct or wall mounting, depending on the application. Range 0 - 2000 ppm (minimum), output 4 - 20 mA linear, accuracy ±75 ppm. |
|   | .2 | Acceptable Materials: QEL CTS-M20, Armstrong AMC 1029 MSA 3630, Texas Instruments 465-4, CET Model AST-8000-CO <sub>2</sub> , Vulcain 90DM2.  |
| <u>2.2 Temperature<br/>Sensors</u>                | .1 | Temperature sensors (other than space temperature sensors specified elsewhere) shall be 100 ohm RTD type, except for above 200°C where thermocouples shall be used.   |

- .2 Duct sensors shall be single point type for use in ducts with a cross sectional area of less than one (1) square metre, and shall be averaging type for all other applications, minimum six (6) metre sensor length.
- .3 Immersion sensors shall be provided with a separable stainless steel well, length 100 mm or 150 mm unless shown otherwise.
- .4 Room temperature sensors shall be 100 ohm RTD or 100,000 ohm thermistor, accuracy  $\pm 0.5^{\circ}\text{C}$  with slotted white plastic cover complete with setpoint adjustment. No temperature indication is required.
- .5 Outside air temperature sensors shall be complete with probe 100mm to 150mm long, non-corroding shield to minimize solar and wind effects, thread fitting for mating to 13mm conduit, weatherproof EEMAC12 enclosure, and suitable for operation from  $-50^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ .
- .6 Accuracies shall be  $\pm 0.5^{\circ}\text{C}$  for standard applications. Where high accuracy is required, accuracy shall be  $\pm 0.1^{\circ}\text{C}$ .
- .7 Temperature sensors in hallways and washrooms shall be plate style to minimize vandalism.

### 2.3 Temperature Transmitters

- .1 As applicable, RTD temperature transmitter to be provided having the following minimum specifications.
  - .1 Input circuit to accept 3-lead, 100 ohm at  $0^{\circ}\text{C}$  platinum resistance detectors as specified in 2.1 above.
  - .2 Output signal of 4-20 mA into maximum of 500 ohm load.
  - .3 Output short circuit and open circuit protection.
  - .4 Input short circuit and open circuit protection.
  - .5 Output variation of less than 0.2% of full scale output for supply voltage variations of  $\pm 10\%$ .
  - .6 Combined non linearity, repeatability and hysteresis effects not to exceed  $\pm 0.5\%$  of full scale output.
  - .7 Maximum current to a 100 ohm RTD sensor not to exceed 25 mA.
  - .8 Integral, zero and span adjustments.
  - .9 Temperature effect of  $\pm 1.0\%$  full scale/ $50^{\circ}\text{C}$  or less.
  - .10 Long term output drift of equal to or less than 0.25% of full scale output/six (6) months.



- .2 Transmitters to be provided with ranges as follows:
  - .1 Outdoor RTD:  $-50^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ ,  $\pm 0.5^{\circ}\text{C}$ .
  - .2 Duct point RTD:  $0^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$   $\pm 0.5^{\circ}\text{C}$ .
  - .3 Immersion (CLG) RTD:  $0^{\circ}\text{C}$  to  $25^{\circ}\text{C}$   $\pm 0.25^{\circ}\text{C}$ .
  - .4 Space RTD:  $10^{\circ}\text{C}$  to  $35^{\circ}\text{C}$   $\pm 0.5^{\circ}\text{C}$ .
  - .5 Immersion (HTG) RTD:  $50^{\circ}\text{C}$  to  $100^{\circ}\text{C}$   $\pm 0.25^{\circ}\text{C}$ .
  - .6 Duct averaging RTD:  $0^{\circ}\text{C}$  to  $50^{\circ}\text{C}$   $\pm 0.5^{\circ}\text{C}$ .
  - .7 Stack Thermocouple:  $0^{\circ}\text{C}$  to  $500^{\circ}\text{C}$   $\pm 1^{\circ}\text{C}$ .

#### 2.4 Humidity Sensors

- .1 Provide humidity sensors as directed with the following minimum specifications.
  - .1 Range of 5-90% RH at minimum.
  - .2 Operating temperature range of  $0^{\circ}\text{C}$  to  $60^{\circ}\text{C}$ .
  - .3 Absolute accuracy of  $\pm 5\%$  RH for duct sensors, and  $\pm 2\%$  for room sensors.
  - .4 Stainless steel sheath construction complete with integral shroud to enable specified operation in air streams of up to 10 m/sec.
  - .5 Maintenance of sensor to be by a simple field method such as solvent or mild detergent solution washing, to remove anticipated airborne contaminants.
  - .6 Maximum sensor nonlinearity of  $\pm 5\%$  RH with defined curve.
  - .7 Room humidity sensors shall be located at the inlet to a return air grille.
  - .8 Duct mounted sensors shall be located such that the sensing element is between one third (1/3) and two thirds (2/3) the distance across the duct interior from any duct wall.

#### 2.5 Humidity Transmitters

- .1 As applicable, provide transmitters for all supplied relative humidity sensors with the following minimum specifications:
  - .1 Input circuit to accept RH sensor as specified elsewhere.
  - .2 Output signal of 4-20 mA into maximum of 500 ohm load.
  - .3 Output short circuit and open circuit protection.
  - .4 Input short circuit and open circuit protection.
  - .5 Output variations of less than 0.2% of full scale output for supply voltage variations of  $\pm 10\%$ .
  - .6 Maximum output linearity error of  $\pm 1.0\%$  of full scale output.
  - .7 Integral zero and span adjustments.
  - .8 Long term output drift of equal to or less than 0.25% of full scale output/ six (6) months.

- .9 Outdoor relative humidity sensors shall be Vaisala HMS112.

2.6 Electrical  
Relays

- .1 Provide double voltage DPDT relays for control and status indication of alarms and/or electrical starters and equipment where shown on point schedule. Relay coils shall be rated for 120V or 24V. Where other voltages occur provide transformer. Contacts rated at 5A at 120V AC. Relays to be plug in type with termination base.

2.7 Current  
Transducer

- .1 Provide current transducers with range specified on point schedule. Current transducers shall measure line current and produce a proportional signal.
- .1 4 - 20mA dc.
  - .2 0 - 1V dc.
  - .3 0 - 10V dc.
  - .4 0 - 20V dc.

2.8 Heavy Duty  
Thermostats

- .1 Shall be heavy duty line voltage, single or two stage as required, heating or cooling as required, with contacts rated 8A 120V AC minimum. Locking cover, removable set point knob and temperature indication. Shield shall be equal to Honeywell T405 or T406 Series.

2.9 Control  
Dampers

- .1 General
- .1 This contractor shall size operators to control dampers against maximum pressure or dynamic closing pressure, whichever is greater.
  - .2 Piston on gear driven type damper operators with spring return to "fail safe" in normally open or normally closed position.
  - .3 Provide sufficient damper motors to achieve unrestricted movement throughout damper range.  
Where dampers are wider than 1200 mm provide external jack shaft with bearings to provide uniform drive pressure to all sections of the damper, and prevent damper twisting, or provide operators at each end to limit driven length to 1200 mm.

- .2 Insulated dampers - Type 1
  - .1 Dampers shall be of 6" extruded aluminum insulated blades, 12 ga. insulated extruded aluminum frames, double sealed bearings, with side and blade seals, rated at less than 0.6% leakage at 10" s.p. Dampers shall be Tamco Series 9000, Ruskin CDTI-50 or Alumavent 3900 Series.
  - .2 Type 1 - O Opposed blade
  - .3 Type 1 - P Parallel blade
- .3 Non-insulated dampers - Type 2
  - .1 This section shall apply to all dampers on the project, other than insulated dampers.
  - .2 Dampers shall be of 6" extruded aluminum airfoil shaped blades, 12 ga. extruded aluminum frames, double sealed bearings, with side and blade seals, rated at less than 0.6% leakage at 10" s.p. Dampers shall be Tamco Series 1000 or Ruskin CD 50
  - .3 Type 2 - O Opposed Blade
  - .4 Type 2 - P Parallel Blade
- .4 Dampers shall be of the following type:
  - .1 Return air: Parallel.
  - .2 Outdoor air/exhaust air: Opposed.
  - .3 Bypass: Parallel.
  - .4 Two Position: Parallel.

#### 2.10 Current Sensing Relay

- .1 Provide current sensing relay having the following minimum capabilities:
  - .1 Relay to be complete with metering transformer ranged to match load being metered.
  - .2 Relay shall be provided with plug in base and shorting shunt (if required) to protect current transformer when relay is removed from socket. Current transformer shall be available for single or three phase metering into single relay.
  - .3 Current relay shall have adjustable latch level, adjustable delay on latch and a minimum differential of 10% of latch setting between latch level and release level.
  - .4 Three (3) phase application shall provide for discrimination between phases to allow detection of worst case selection. Current relay shall be powered from control circuit of motor starter being metered and shall be suitable for mounting in the motor starter cabinet.
  - .5 Relay contacts shall be capable of handling 10 amps at 240 volts.

- .6 Coordinate any current relay requirements with those provided under Division 16.

2.11 Damper  
Operators  
Electronic

- .1 Provide rotary type direct coupled electronic proportional damper operators where indicated or required. Only Belimo actuators are acceptable. Spring return for "fail-safe" in normally open or normally closed position where required. Provide spring returns for all outside air intake, relief air and fan shut off dampers. Size operators to control dampers against maximum pressure or dynamic closing pressure whichever is greater. Power Requirements 5 VA maximum at 24V AC. Operating Range to match analog outputs specified in Section 15930.

2.12 Terminal  
Equipment  
Controller Valves

- .1 The electronic actuator shall be mounted on the valve body and provide complete modulating control of the valve.
- .2 The actuator motor shall de-energize when the valve has reached the operator or system determined position. It will not re-energize until an output change is required. Valves will hold position without having to energize in a pulse width modulation type mode. Thermally actuated valves are not acceptable.
- .3 Valve position status shall be monitored from the central or remote operator's terminal and shall be displayed in percent open notation.
- .4 The actuator shall be removable without removing the valve from service or draining the system.
- .5 Valves shall fail open.
- .6 The valve body shall be bronze, rated as follows:

	<u>2-Way</u>	<u>3-Way</u>
Flow Characteristics:	Equal percentage	Linear bypass, equal percentage flow through.
Pressure drop	2.5 psi (17 kPa)	2.5 psi (17 kPa)
Pressuring rating:	ANSI Class 125	ANSI Class 125

- .7 Acceptable Material: Belimo Zone Tight Z2050Q-J+CQKB24-LL, Erie Pop Top AG23A020.

2.13 Power/Energy  
Metering

- .1 Provide current transformers of correct ratio, two (2) for three (3) phase 3 wire and three (3) for three (3) phase 4 wire, and potential transformers ratio 600/120 volt for 600 volt three (3) phase services. Metering transformers shall be in accordance with ANSI C57.13.
- .2 Division 16 shall install these C.T.s and P.T.s. Provide HRC fuses for potential transformer primary protection.
- .3 For each metered service, provide a suitable transducer, three (3) phase 3 or 4 wire as required, having 5 amp and 120 volt, input 60 Hz and 4 to 20 mA D.C. output proportional to power (kW). Input burden not to exceed 0.5 VA, accuracy 0.25% rated output, span and zero adjustment 5%, input overload capacity up to three (3) times rated and input load resistance up to 500 ohms.
- .4 Provide each metering system with a relay operated by the potential transformer. In the event of power failure, the contacts shall open and the output signal shall be sent to the BAS panel.

PART 3 - EXECUTION

3.1 Installation

- .1 Provide all remote sensing points and instrumentation as indicated and/or required for the complete operational capability of the BAS.
- .2 All equipment shall be installed according to manufacturer's published instructions.
- .3 All sensors shall be stabilized to such a level as to permit on-the-job installations that will require minimum field adjustments or calibration.
- .4 Sensor assemblies shall be readily accessible and adaptable to each type of application in such a manner as to allow for quick, easy replacement and servicing without special tools or skills.
- .5 Outdoor installation shall be weatherproof enclosures. These installations shall be protected from solar radiation and wind effects by shields.
- .6 Sensors located in finished spaces shall be with brushed aluminum covers, and guards where indicated.

- .7 Sensors in ducts shall be mounted in locations to sense the correct temperature of the air only, and shall not be located in dead air spaces. The location shall be within the vibration and velocity limits of the sensor. Where an extended surface element is required to properly sense the average temperature it shall be securely mounted within the duct to measure the best average temperatures. Elements shall be thermally isolated from brackets and supports to respond to air temperature only.
- .8 Wells shall be installed by the piping contractor for all piping installations. Where pipe diameter is less than the insertion length of the well, the well shall be installed at an elbow location to effect proper flow across entire well area. Well, when installed, shall not restrict flow in piping by more than 30% (i.e. well shall not represent more than 30% of pipe as measured on a cross section by area). If necessary, increase pipe size at measurement location to meet this criteria.
- .9 Temperature transmitters, humidity transmitters, current to pneumatic transducers, solenoid air valves, controllers and relays to be installed in enclosures.
- .10 Panels to be either free standing or wall mounted. Arrange for conduit and tubing entry from top, bottom or either side.
- .11 Panels shall be modular multiple panels being used if required for capacity in any particular location. They shall handle all requirements with space to accommodate an additional 20% without adding further cabinets.
- .12 All wiring and tubing within panels to be located in trays or individually clipped to back of panel, and clearly identified.
- .13 Field mounted transmitters and sensors to be properly supported on pipe stands or channel brackets, all wall mounted devices to be properly attached to the wall.
- .14 All field devices to be properly identified.

### 3.2 Control Dampers

- .1 Supply control dampers unless indicated as "packaged with unit" on the drawings or in the specifications.

- .2 Provide electronic actuators for all control dampers, including those packaged with units.
- .3 Dampers will be installed by sheet metal trade in ductwork, as indicated, or in packaged air handling units by the unit supplier.

### 3.3 Installation of Sensors

- .1 Sensors provided under this contract shall be installed in accordance with the manufacturer's prescribed procedure.
- .2 Wall mounted space temperature sensors shall be installed at 1200mm above the finished floor to meet barrier free accessibility requirements. Where space sensors are installed on perimeter columns, install on cork gaskets, and seal hole in drywall with silicone sealant.
- .3 Sensors shall be rigidly mounted and mountings shall be adequate for the environment within which the sensor operates.
- .4 Averaging type RTD's as specified shall be used wherever the points schedule of these specifications indicates a mixed air temperature is to be monitored. Averaging type RTD's shall be installed in a serpentine configuration with adequate provision for the mechanical protection of the sensor and such that it is supported as required along its entire length.
- .5 Duct type RTD's as specified, shall be used for the monitoring of all air temperatures except mixed air temperatures.
- .6 Spring loaded (Thermowell) mount RTD's, as specified, shall be used for the temperature monitoring of liquids.
- .7 Differential pressure switches shall monitor the differential pressure across fans and shall not reference ambient pressure. For fans, the BAS contractor shall provide his own tappings which shall be as close as possible to the fan inlet and fan discharge. The BAS contractor shall obtain the approval of the Owner prior to installation of the tappings.
- .8 Duct and plenum cutting and patching where necessary shall adhere to the following:
  - .1 Cutting to be kept to a minimum and conducted in a neat workmanlike manner.

- .2 Patches shall be of same material and thickness as adjoining ductwork and have minimum thickness of 0.76 mm.
- .3 Gaskets, seals and insulation shall be applied as necessary.
- .4 Fasten with sheet metal screws.

END OF SECTION



## PART 1 - GENERAL

1.1 General .1 Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.

1.2 General Requirements .1 This section is intended to cover all new installations that are carried out by the contractor. The contractor shall be responsible to identify any aspects of the existing installation that do not meet this specification, or otherwise comply with good installation practice, and bring them to the attention of the owner to determine what remedial action if any shall be undertaken.

.2 The contractor shall be entirely responsible to determine the suitability of any materials they are intending to reuse for this project, prior to submission of a tender. With the exception of the field devices, the contractor is expected to carry out whatever testing is necessary to ensure the product, wiring, conduit, etc is suitable in all regards. No additional claim will be considered for materials that were to be reused that the contractor subsequently decides are not suitable. The contractor has thirty (30) days from award of contract to determine any malfunctions in existing field devices and to report such malfunctions in writing to the Owner. The Owner shall then have the option to repair the devices at his cost, or to issue a Change Order for the contractor to repair.

.3 In the event that the contractor does not notify the Owner in writing within the specified period of a malfunction in any field device, it shall be deemed that the contractor has tested the operation and that the devices operate properly. At this time the contractor shall become totally responsible for the satisfactory operation of the system and all devices both new and existing, including the replacement of any devices that subsequently prove to operate improperly. In this way the responsibility for damage to system components during construction becomes that of the contractor.

1.3 Codes and Standards .1 Carry out all work in accordance with these drawings and specification, meet latest regulations of Canadian Electrical Code and applicable Municipal and Provincial Codes and Regulations. In each and every instance of application, Code, Regulation, Statute, By-law or specification having most stringent requirements applies.

#### 1.4 Permits and Fees

- .1 Submit to Inspection Authority and Supply Authority necessary number of working drawings and specifications for examination and approval prior to commencement of work and pay all associated fees.
- .2 Obtain and pay for all electrical inspection fees.
- .3 Obtain a Certificate of Acceptance from Inspection Authority on completion of work and hand it over to Consultant.
- .4 Notify inspection authority in sufficient time for them to inspect work.
- .5 Consultant will carry out general reviews of construction and prepare deficiency lists during and on completion of construction.

#### 1.5 Description of System

- .1 All power wiring to bring required power from panelboards to the control panels being provided shall be by the controls contractor, and shall be from emergency panels where the controllers support life safety systems or any other systems designed to operate on emergency power. Coordinate with the electrical drawings and contractor.
- .2 Provide all hard wiring between field devices, both sensors and control devices and BAS field panels.
- .3 Provide all wiring between field panels and main control centre.
- .4 Starters shall be provided with necessary control interface by BAS as shown in the tables of control points and as detailed on the electrical drawings.
- .5 All wiring and conduit to be in accordance with full requirements of electrical specifications.

#### 1.6 Qualifications

- .1 Contractor to have qualified personnel to continuously direct and monitor all electrical and mechanical work.
- .2 Supervisory personnel to attend all site meetings.

### 1.7 Conduit and Wire

- .1 Size of conduit and type of wire for main BAS trunk wiring are the design responsibility of the BAS contractor. Information on sizes and types must be provided by the BAS contractor in order to complete the information shown on the drawings.
- .2 All wiring to be in conduit except in concealed areas where return air plenum rated cable may be used. Supply and install conduit all in accordance to the electrical specifications.
- .3 Essential communication, conduits for emergency life safety systems shall be protected against damage for two (2) hour period by either embedding the conduit in the concrete structure or using suitable M.I. cable.
- .4 All BAS wiring shall be orange in colour.
- .5 Zip ties or Velcro straps shall not be acceptable for supporting wiring, conduits or other related systems.

### 1.8 Responsibility for Quantities

- .1 Failure to carry the correct lengths or sizes of conduit or correct types of wire or the correct number of BAS panels shall be the contractors responsibility and shall not be the basis for additional charges by contractor.

### 1.9 Equipment Identification

- .1 Identify all equipment supplied under this Division. Hand-painted identification will not be accepted. Wording on labels to be approved by Consultant. Allow for average of twenty-five (25) letters per label. All identification to be in English.
- .2 It is the intent of this section that at the end of construction, all new and existing equipment be clearly identified as outlined in this section, whether the existing is properly wired before the start of construction or not.

### 1.10 Wiring Identification

- .1 Provide numbered tape markings on all branch control wiring, and pneumatic tubing. At all junction boxes, splitters, cabinets and

outlet boxes, maintain identification system. Use colour coded wires in communication cables, matched throughout system.

- .2 It is the intent of this section that at the end of construction, all new and existing wiring be clearly identified as outlined in this section, whether the existing is properly wired before the start of construction or not.

### 1.11 Conduit Identification

- .1 Colour code all BAS conduits. Coding to be located on all conduits and cables exposed after completion of construction in all locations including tunnels and shafts. Coding to be plastic tape or paint at all points where conduit or cable enters wall, ceiling, or floor, and at 15 metre intervals.
- .2 It is the intent of this section that at the end of construction, all new and existing conduit be clearly identified as outlined in this section, whether the existing is properly wired before the start of construction or not.

## PART 2 - PRODUCTS

### 2.1 Wiring

- .1 Standards:
  - .1 Chemically cross-linked thermosetting polyethylene wire and cable to CSA C22.2 No.38-1977.
  - .2 Wire connectors to CSA C22.2 No.65-1956.
  - .3 Armoured cables to CSA C22.2 No.51-1966.
  - .4 Grounding and bonding equipment to CSA C22.2 No.41-1950, and C22-1975 Section 10.
- .2 Provide copper conductors sized as indicated, with cross-linked thermosetting polyethylene insulating material rated RW90 and 600V as follows:
  - .1 Size all power supply wiring per Code to match or exceed breaker size, minimum No.12.
  - .2 Minimum No.14 for control wiring and stranded.
  - .3 Field wiring for each digital device shall be No.20 AWG, stranded, twisted pair. For multi-conductor wire having four or more conductors, wire size shall be not less than No.22 AWG solid copper. Analog input shall be wired with shielded, No.20 AWG, stranded, twisted and shielded pair, copper wire.

- .3 All wires shall be terminated with pressure type connectors suitable for wire size and materials as well as terminal connection. Wire in physical contact with compression screw shall not be acceptable.
- .4 All concealed wire shall be FT6 plenum rated unless in conduit.
- .5 All exposed wiring shall be in conduit.

## 2.2 Conduit System

- .1 Provide a complete conduit system to link all network controllers to the OWS. Size of the conduits required are to suit the wiring for the system and to allow for the future expansion capabilities specified for the systems. Existing conduits may be used only if they meet the requirements of this specification.
- .2 Standards:
  - .1 Junction, Pull boxes and cabinets to CSA C22.2 No.40-1973.
  - .2 Outlet boxes, conduit boxes and fittings to CSA C22.2 No.18-1973.
- .3 Junction and Pull Boxes:
  - .1 Junction and pull boxes of welded steel construction with screw-on flat covers for surface mounting.
  - .2 Covers with 25 mm minimum extension all around, for flush mounted pull and junction boxes.
  - .3 Provide pull boxes so as not to exceed 30,000 mm of conduit run between pull boxes.
- .4 Cabinets:
  - .1 Sheet steel cabinet for surface mounting with hinged door, latch lock.
- .5 Sheet Steel Outlet Boxes:
  - .1 100 mm square outlet boxes minimum.
- .6 Conduit - General:
  - .1 Supply and installation of conduit types shall be based on the application as outlined in Division 26, specification section 260534.

### 2.3 Wiring Devices and Cover Plates

- .1 Standards:
  - .1 Manually-operated general purpose AC switches to CSA C22-2 No.111-1956 and 55-1975.
  - .2 Receptacles, plugs and similar wiring devices to CSA C22.2 No.42-1959.
- .2 Receptacles:
  - .1 Duplex receptacles, CSA type 5-15R, Hubbel No. 5262-1.
  - .2 Single receptacles, CSA type 5-15R, Hubbel No. 5261.
- .3 Cover plates:
  - .1 Cover plates for all wiring devices.
  - .2 Blank plates, finish to match other plates in area, for boxes without wiring devices.

### 2.4 Starters Control Devices

- .1 All starters are existing. Provide additional relays as may be required by sequence of operation.

### 2.5 Fastenings and Supports for Conduits and Equipment

- .1 Use lead anchors or nylon shields to secure equipment to solid masonry tile and plastic surfaces, and toggle bolts to secure equipment to hollow masonry walls or suspended drywall ceilings.
- .2 Straps for fastening of exposed conduits or cables to building construction or support system. One-hole steel straps to secure exposed conduits and cables 50 mm or smaller. Two-hole steel straps for conduits and cables larger than 50 mm.
- .3 Support individual suspended cable or conduit runs with 6 mm threaded rods and support clips. Support two (2) or more suspended cables or conduits on support channels supported by 6 mm threaded rod hangers.
- .4 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated, or as required to support conduit and cable runs.

- .5 Do not use wire lashing or perforated strap to support or secure raceways or cables. Provide adequate support for raceways and cables sloped vertically to equipment.
- .6 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Consultant.

### PART 3 - EXECUTION

#### 3.1 General

- .1 The installation shall conform to manufacturer's recommended procedures and local codes.
- .2 All installations to be performed by skilled and certified technicians.
- .3 All equipment installed shall be mechanically stable and, as necessary, fixed to wall or floor. Anti-vibration mounts to be provided, if required, for the proper isolation of the equipment.
- .4 Equipment shall be installed so as to allow for easy maintenance access. Equipment shall be installed such that it does not interfere in any way with access to adjacent equipment and personnel traffic in the surrounding space.
- .5 Equipment shall be installed in locations providing adequate ambient conditions for its specified functioning, allowing for adequate ventilation and with no condensate traps.
- .6 Permanently identify each wire, cable and conduit as specified elsewhere.

#### 3.2 Conduit, Wiring, Cabling and Fittings

- .1 Provide wiring for all devices specified in the Controls Section. Identify each wire and cable at every termination point.
- .2 The sizing and provision of conduit and type of wire for the main BAS trunk wiring are the design responsibility of the BAS contractor.

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- .3 Where there is no alternative to supplying equipment which is not CSA certified, submit such equipment to Inspection Authorities for special inspection and obtain approval before delivery of equipment to site. Such equipment must be identified in the contractor's proposal.
- .4 Carry out all work in accordance with these specifications. Meet latest regulations of Canadian Electrical Code and applicable Municipal and Provincial codes and regulations. In each and every instance of application, code, regulation, statute, or by-law, specification having most stringent requirement applies.
- .5 Canadian Standards Association's Electrical Bulletins complement related Canadian Electrical Code, Part II Standards. CSA Electrical Bulletins in force at time of tender submission, while not identified and specified by number in this specification, are to be considered as forming part of related CSA Part II Standard and must be complied with.
- .6 Obtain and pay for all electrical inspection fees at no additional cost to the Owner.
- .7 Perform circuit tests using qualified personnel only. Provide necessary instruments and equipment to demonstrate that all circuits are continuous and free from short circuits and grounds, that all circuits are free from unspecified grounds, and that resistance to ground of all circuits is no less than 50 megohms.
- .8 Do not run exposed conduit in normally occupied space unless approval of the Owner has been previously obtained for each specific case.
- .9 Use conduit based on the application as outlined in specification section 260534 for all building runs, both concealed and surface. Install runs parallel or perpendicular to building lines in a neat and workmanlike manner.
- .10 Junction and pull boxes shall be of welded steel construction, suitable for surface mounting, with screw-on flat covers. Provide pull boxes so as not to exceed thirty (30) metres of conduit run between pull boxes.



- .11 Where connection is required to moving or vibrating equipment, the last three (3) metres of conduit, at minimum, shall be flexible.
- .12 Mechanically support all conduit in a manner as satisfactory to the Owner.
- .13 In damp locations waterproof flexible conduit must be used.
- .14 Provide complete testing for all wiring installed or utilized under this contract. Provide all equipment, tools, and personnel as necessary to conduct these tests.
- .15 All communication trunk, sensing, and transmitter wiring shall be, at minimum, #18 AWG. Trunk cables shall not be spliced.

END OF SECTION



## PART 1 - GENERAL

### 1.1 General

- .1 Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.
- .2 Wiring of any voltage (including 120V), conduit, etc. required to meet the sequence stated shall by this Division, unless specifically stated otherwise.
- .3 All scheduled operation of equipment shall be on time of day, day of the week, and include holidays.
- .4 All alarm signals shall be monitored by the school's security system. Coordinate with the security system provider and provide suitable output signals.

### 1.2 RTU Operation

- .1 The BAS shall enable/disable the units individually on a time of day/day of week schedule.
- .2 During the occupied mode, the circulation fan(s) shall run continuously.
- .3 The BAS shall monitor and reset the supply air temperature setpoint of each RTU. The rooftop units shall initiate heating, mechanical cooling, and economizer (dual enthalpy) as required to maintain the supply air temperature setpoint through their built-in controller.
- .4 The supply air temperature setpoint shall be reset based on an average of the wall mounted temperature sensors located in the areas served by the unit as well as a common return air temperature sensor. The BAS shall have the ability to assign additional "weight" to selected temperature sensors to provide higher influence on the supply air temperature reset, or to remove sensor inputs altogether. Adjustments shall be performed as required during the seasonal commissioning process.
- .5 The existing wall mounted temperature sensors shall activate the perimeter heating system (hot water heater control valves) through the BAS to maintain the room temperature setpoint as per the current sequence. The BAS shall not activate the perimeter heating when the associated rooftop unit is in cooling mode.

- .6 The rooftop unit gas heating shall be locked out when the OAT is above 15 deg C.
- .7 The BAS shall monitor the carbon dioxide (CO2) concentration in the return air to the rooftop unit to modulate the rooftop unit outdoor air intake above the minimum setting. Should the supply air temperature setpoint not be able to be maintained due to the outdoor air climatic conditions, the BAS shall reduce the outdoor air intake as required.
- .8 The outdoor air intake damper shall remain closed when:
  - The circulation fans are OFF
  - Night setback operation (except to provide free cooling)
  - Morning Warm-up operation
- .9 During unoccupied periods (time of day scheduling) rooftop equipment shall maintain:  
Winter: 15.5 deg C  
Summer: 27 deg C
- .10 During morning warmup the RTU shall be enabled at 6:00 AM (adjustable). Outdoor air intake damper shall remain closed and heating shall be enabled.
- .11 An override pushbutton on each room temperature sensor shall permit a timed override (3 hours) of the room's heating system night setback.
- .12 The BAS shall monitor the following:
  - Unit status
  - General fault
  - Filter status.
- .13 The BAS shall signal the following alarms:
  - Low return air temperature
  - High supply air temperature
  - Low space temperature (below 10 deg C)
- .14 RTU-23 and RTU-25 shall operate under the same schedule. Should one unit operate after hours, the other unit shall start. Fan F-1 shall operate whenever the units operate. The BAS shall monitor the fan F-1 inlet duct static pressure within the 2<sup>nd</sup> floor

ceiling space and send a modulating signal to the fan F-1 variable speed drive. Static pressure setpoint shall be set during the balancing procedures to match the RTU-23 and 25 total supply airflow.

- .15 Fan F-2 shall operate whenever RTU-24 operates. The BAS shall monitor the fan F-2 inlet duct static pressure within the ground floor ceiling space and send a modulating signal to the fan F-2 variable speed drive. Static pressure setpoint shall be set during the balancing procedures to match the RTU-24 supply airflow.
- .16 Air heat recovery systems in rooftop units shall be controlled by the rooftop unit controller. Provide interconnecting wiring between the rooftop unit and the heat recovery system as per manufacturer's instructions.

### 1.3 Welding Shop Make-Up Air Unit MUA-3

- .1 The BAS shall enable/disable the unit whenever the existing welding fume hood exhaust fan system is activated. When the welding fume hood exhaust system is OFF, the make-up air unit shall not operate and the outdoor air intake damper shall be closed.
- .2 When operating, the make-up air unit shall modulate the natural gas burner to maintain a supply air temperature setpoint of 22 deg C. The supply air temperature shall be monitored by the BAS.
- .3 The BAS shall monitor following:
  - Unit status
  - General fault
  - Filter status.
- .4 The BAS shall signal the following alarms:
  - Low supply air temperature
  - High supply air temperature

### 1.4 Kitchen Make-Up Air Units MUA-1 & MUA-2

- .1 The BAS shall enable/disable the units individually whenever their associated existing kitchen hood exhaust fan systems are activated. Provide monitoring of existing exhaust fan operation.
- .2 When a kitchen hood exhaust system is activated, the make-up air unit return and outdoor air intake dampers shall be positioned to provide 100% outdoor air to the kitchen. The BAS shall monitor the space temperature and reset the supply air temperature setpoint as required.
- .3 When a kitchen hood exhaust system is OFF, the associated make-up air unit shall also be OFF, O/A damper closed, R/A damper open, unless:

After hours: The associated make-up air unit shall remain OFF.

Occupied hours: The associated make-up air unit may operate in recirculation mode to maintain the space temperature setpoint. If the space temperature is satisfied, the unit shall not operate.

- .4 The BAS shall monitor following:
  - Unit status
  - General fault
  - Filter status.
- .5 The BAS shall signal the following alarms:
  - Low supply air temperature
  - High supply air temperature
  - Low space temperature
  - High space temperature
- .6 Provide interlocking wiring between make-up air units and their remote condensing units. All wiring shall be in conduits.

#### 1.5 Classroom Ventilators

- .1 The BAS shall control the classroom ventilators from a remote wall mounted temperature sensor. The BAS contractor shall replace existing wall mounted sensors as required to suit the new unit requirements.
- .2 The wall mounted temperature sensor shall control the classroom ventilator heating/cooling system, as well as the existing perimeter

hot water baseboard heater motorized valves. When heating is required, the perimeter baseboard heaters shall be activated along with the classroom ventilator heating system.

- .3 A carbon dioxide (CO2) sensor within each unit shall modulate the outdoor air intake.
- .4 The BAS shall monitor a general fault signal from the classroom ventilators.
- .5 Temperature setpoint shall be 23 deg C during the cooling season and 21 deg C during the heating season.
- .6 After hour operation:  
During the cooling season, the classroom ventilators shall be OFF. During the heating season, the BAS shall operate the perimeter baseboard heaters as the primary source of heat to maintain a night setback temperature setpoint of 18 deg C, and start the classroom ventilators to supplement the perimeter heating system should the space temperature drop below 17 deg C.
- .7 The BAS shall signal an alarm signal should the space temperature drop below 10 deg C.
- .8 Coordinate BAS requirements with the classroom ventilator equipment supplier prior to submission of classroom ventilator and Controls shop drawings.

#### 1.6 Ventilation fan F-7

- .1 The BAS shall operate the fan based on a time of day/day of the week schedule. The fan shall operate when the school is occupied, and stop when the school is not occupied.

END OF SECTION





## PART 1 - GENERAL

- |                                 |    |  |
|---------------------------------|----|--|
| <u>1.1 General</u>              | .1 | These instructions apply to all electrical trades employed on this project.  |
| <u>1.2 General Requirements</u> | .1 | Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.  |
| <u>1.3 Documents Required</u>   | .1 | Maintain at job site, one copy each of the following: <ul style="list-style-type: none"><li>.1 Contract drawings</li><li>.2 Specifications</li><li>.3 Addenda</li><li>.4 Reviewed shop drawings</li><li>.5 Change orders</li><li>.6 Other modifications to contract</li><li>.7 Field test reports</li><li>.8 Copy of approved work schedule</li><li>.9 Manufacturer's installation and application instructions.</li></ul> |
| <u>1.4 Work Schedule</u>        | .1 | Prior to first application for payment, provide a schedule showing anticipated progress stages and final completion of work.   |
|                                 | .2 | Work schedule shall be in sufficient detail to allow cross referencing to the progress claim breakdown.  |
|                                 | .3 | Submit and updated schedule monthly with the progress payment claim.   |
| <u>1.5 Cost Breakdown</u>       | .1 | Before submitting the first progress payment claim, submit detailed breakdown of contract price for review and approval of the Consultant and Owner aggregating to the total contract value. Submit breakdown not less than 14 days prior to making first progress claim, and arrange to have a review meeting with Consultant. Make revisions to breakdown as agreed with Consultant prior to submitting first claim.     |

- .2 The breakdown shall be in sufficient detail to identify the labour, material, and start-up for each system, sub system and equipment on a floor by floor basis and area basis, to easily allow verification of progress of work. The information contained herein shall be consistent with the monthly Contractor Status Report information using the same categories expanded and in greater detail where required to identify the value of work executed, and to meet the criteria outlined herein. The breakdown shall include major equipment suppliers (those supplying equipment requiring a delivery timeline of more than 2 weeks after shop drawing review).
- .3 Each line item shall include for the contractors over head and profit such that the aggregate amount totals to the contract value without applying multipliers.
- .4 Multiple pieces of equipment that are supplied from one source, shall be broken down into logical categories consistent with the construction and required delivery schedule to meet this criteria.
- .5 The breakdown shall identify separately the testing, adjusting and balancing work, the stipulated commissioning amount, and all cash allowances contained in the contract documents.
- .6 The Consultant reserves the right to request copies of the quotations from suppliers or sub-contractors to verify the cost of materials or services shown in the detailed breakdown where in his opinion there is any doubt as to the adequacy of the amount shown.
- .7 Notwithstanding the above, the Consultant may, in his sole discretion, authorize payment against a progress draw prior to final approval of the cost breakdown where in the Consultant's opinion the contractor has made reasonable efforts to provide supplementary information and to revise the breakdown in accordance with the discussions with the Consultant. Such authorization for payment shall not be deemed to give approval of the cost breakdown for future payments and every effort shall be made by the contractor to provide the breakdown satisfactory to the Consultant before any subsequent payment requests.

1.6 Contractor's  
Use of Site

- .1 Do not unreasonably encumber site with materials or equipment.

- .2 Move stored products or equipment which interfere with operations of Consultant or other Contractors.
- .3 Obtain and pay for use of additional storage or work areas needed for operations.

#### 1.7 Codes and Standards

- .1 Perform work in accordance with the Ontario Building Code (OBC), the Ontario Electrical Safety Code, and any other code of provincial or local application provided that in any case of conflict or discrepancy the more stringent requirements shall apply.
- .2 Meet or exceed requirements of contract documents, specified standards, codes and referenced documents.
- .3 Do overhead and underground systems in accordance with CSA C22.3No.1 except where specified otherwise.
- .4 Abbreviations for electrical terms: to Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC) - IEEE Standards Dictionary CD 100.
- .5 Where requirements of this specification exceed those of above mentioned standards, this specification shall govern.
- .6 Comply with all municipal, provincial and federal laws, regulations, and by-laws including, but not limited to, those concerning the environment and the disposal of waste. The contractor shall inform itself of such requirements.

#### 1.8 Location of Equipment and Fixtures

- .1 Location of equipment, fixtures and outlets indicated or specified are to be considered as approximate.
- .2 Locate equipment, fixtures and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.
- .3 Inform Consultant of impending installation and obtain his approval for actual location.

- .4 Submit field drawings to indicate relative position of various services and equipment when required by Consultant.

1.9 Cutting, Fitting  
and Patching

- .1 X-ray floors and structural walls before cutting to locate existing rebar and conduits and to obtain Owner's approval for proposed cutting or core drilling.
- .2 Execute cutting, excavation, fitting and patching required to make work fit properly.
- .3 Where new work connects with existing and where existing work is altered, cut, patch and make good to match existing work.
- .4 Make cuts with clean, true, smooth edges. Make patches inconspicuous in final assembly.
- .5 Fit work airtight to pipes, sleeves, ducts and conduits.

1.10 Existing  
Services

- .1 Where work involves breaking into or connecting to existing services, carry out work at times directed by governing authorities, with minimum of disturbance to pedestrian and vehicular traffic.
- .2 Before commencing work, establish location and extent of service lines in area of work and notify Consultant of findings.
- .3 Submit schedule to and obtain approval from Consultant for any shut-down or closure of active service or facility. Adhere to approved schedule and provide notice to affected parties.
- .4 Where unknown services are encountered, immediately advise Consultant and confirm findings in writing.
- .5 Remove abandoned service lines within 2 m of structures. Cap or otherwise seal lines at cut-off points as directed by Consultant.
- .6 Record locations of maintained, re-routed and abandoned service lines.

1.11 Shut-downs of  
Services and  
Systems

- .1 All shut-downs to be in accordance with Sections 00 and 01.
- .2 Contractors are to verify with Owner before making any connection to any existing systems. This will ensure that (1) the Owner is aware that work will be done on a system and (2) that the contractor is working on a system that is working when he starts his work.

1.12 Alterations,  
Additions or Repairs  
to Existing Building

- .1 Execute work with least possible interference or disturbance to occupants, public and normal use of premises. Arrange with Consultant to facilitate execution of work.
- .2 Where security has been reduced by work of Contract, provide temporary means to maintain security.
- .3 Provide temporary dust screens, barriers, warning signs in locations where renovation and alteration work is adjacent to areas used by public or government staff.

1.13 Additional  
Drawings

- .1 Consultant may furnish additional drawings to assist proper execution of work. These drawings will be issued for clarification only. Such drawings shall have same meaning and intent as if they were included with plans referred to in contract documents.

1.14 Taxes

- .1 Pay all taxes properly levied by law including Federal, Provincial and Municipal.

1.15 Fees, Permits  
Certificates

- .1 Pay all fees and obtain all permits. Provide authorities with plans and information for acceptance certificates. Furnish inspection certificates as evidence that work conforms with requirements of authority having jurisdiction.

1.16 Explosive  
Actuated Devices

- .1 Do not employ power guns using explosives, unless permitted expressly by the Structural Consultant; comply with fastening requirement of CSA Z-166 (Safety Code for Explosive Actuated Tools). Ensure concrete slabs not adversely affected.

1.17 Examination  
and Site Visit

- .1 Examine site and conditions likely to affect work. Submissions of tender deemed confirmation that tenderer has inspected site and is conversant with conditions.
- .2 Extras will not be considered based on situations which could reasonably have been foreseen by a close inspection of the site.

1.18 Warranty

- .1 Contractor to provide all labour and material to promptly correct defects or deficiencies in the work and the performance of the work, which appear prior to and during the one year Warranty period. The Warranty is to include complete labour and material Product warranties for all Products included in the work.
- .2 The Warranty period for the corrected work is to be extended for an additional year following the correction of defects and deficiencies in the work carried out in the initial warranty period.
- .3 The start of the Warranty period for completed electrical work shall commence on the date of substantial completion unless stated otherwise.
- .4 Certain items of equipment have extended warranties required in the specifications. Collect all agreements, guarantees, and warranty certificates and provide to the Owner.

1.19 Contract

- .1 Project drawings and specifications are complimentary to this General Specification. In cases of conflict, ambiguity or doubt, apply to the Consultant for a ruling in writing prior to tender closing. Once the Tender has closed, the Consultant's ruling shall be final and binding; claims for extras will not be accepted.
- .2 All jobs must be complete, performed and finished in a workmanlike manner. Work and materials of an incidental nature, necessary by

implication to produce the finished job as specified, shall be supplied, even when not listed or described in detail.

- .3 No deviations from the specifications or drawings will be allowed without written permission of the Consultant.

1.20 As-Built  
Drawings by  
Contractor

- .1 The successful contractor shall be responsible for a complete set of as-built drawings.
- .2 A set of prints shall be kept up-to-date as the work progresses. Show all changes and deviations from the original tender documents whether they be issued change orders, site instructions or contractor's changes.
- .3 Record exactly the location of services where concealed or buried or where capped or plugged for future use. As-built drawings shall show conduit sizes and runs, junction boxes, pull boxes, wiring with circuit numbers.
- .4 The Consultant shall make available the Tender Issue of the drawings. This contractor shall update these with all Change Orders, Site Instructions, and to reflect site conditions. An amount of nominally 2% of contract value shall be held back until these drawings are completed to the entire satisfaction of the Consultant.
- .5 The Consultant reserves the right to request a number of verifications necessary to prove the exactness of the as-built drawings.
- .6 Within two weeks of achieving Substantial Completion of the Project, the contractor shall turn over a complete set of as-built drawings (marked up white prints in red ink) to the Consultant. The Consultant shall incorporate information received via the as-built drawings onto a set of Record Drawings for the Client.

1.21 Definitions

- .1 "Acceptable Material": means that item named and specified by catalogue number forms parts of specification and sets standard regarding performance, quality of material and workmanship, and when used in conjunction with a referenced standard, shall be deemed to supplement the standard. Equipment proposed shall be

one of the named suppliers. Approval for other products/suppliers shall be obtained from the Consultant prior to tender closing. Such approval must be in writing.

- .2 "Equal to", or "or equal": Means that other products meeting the same specification as the named product will be accepted as equal without prior approval as an alternate. The Consultant's decision will be final as to whether the product meets the specification in all respects, and if not, the named product shall be supplied. In general, the building systems have been engineered around those products named in the equipment schedules as shown on the drawings. In the event that a product, identified in this specification as an 'Equal', is selected for use by this contractor any additional costs resulting from the use of this equivalent product shall be borne by the responsible contractor. No extras will be considered.

#### 1.22 Responsibility for Trial Usage

- .1 Obtain written permission from Owner to start and test permanent equipment and systems prior to acceptance by Consultant.
- .2 Consultant or Owner may use equipment and systems for test purposes prior to acceptance. Supply labour, material and instruments required for testing.

#### 1.23 Shop Drawings

- .1 General:
- .1 The Consultant shall review or take other appropriate action on the Contractor submittals, such as shop drawings, product data, samples and other data, which the Contractor is required to submit, but only for the limited purposes of checking for conformance with the design concept and the information shown in the Construction Documents. This review shall not include review of the accuracy or completeness of details, such as quantities, dimensions, weights or gauges, fabrication processes, construction means or methods, coordination of the work with other trades or construction safety precautions, all of which are the sole responsibility of the Contractor.

The Consultant's review shall be conducted with reasonable promptness while allowing sufficient time in the Consultant's judgment to permit adequate review. Review of a specific



item shall not indicate that the Consultant has reviewed the entire assembly of which the item is a component. The Consultant shall not be responsible for any deviations from the Construction Documents not brought to the attention of the Consultant in writing by the Contractor. The Consultant shall not be required to review partial submissions or those for which submissions of correlated items have not been received.

- .2 Submit to the Consultant, for review, shop drawings, product data and samples specified. Until submission is reviewed, work involving relevant product may not proceed.

.2 Shop Drawings:

- .1 Drawings by Contractor, Sub-contractor, supplier or distributor, shall be prints which illustrate appropriate portion of work, showing fabrication, layout, setting or erection details as specified in appropriate sections.
- .2 Identify details by reference to sheet and detail numbers shown on contract drawings.
- .3 Maximum sheet size 44" x 34" (1120 mm x 860 mm).

.3 Product Data:

- .1 Certain specification sections specify that manufacturer's standard schematic drawings, catalogue sheets, diagrams, schedules, performance charts, illustrations and other standard descriptive data will be accepted in lieu of shop drawings.
- .2 Above will only be accepted if they conform to the following:
  - .1 Delete information which is not applicable to the project.
  - .2 Supplement standard information to provide additional information applicable to project.
  - .3 Show dimensions and clearances required.
  - .4 Show performance characteristics and capacities.
  - .5 Show wiring diagrams and controls.
  - .6 Show voltage, phase and power (HP, watts, amps).
- .3 Indicate details of construction, dimensions, capacities, weights and electrical performance characteristics of equipment or material.
- .4 Where applicable, include wiring, single line and schematic diagrams.
- .5 Include wiring drawings or diagrams showing interconnection with work of other Divisions or Sections.

- .4 Coordination of submissions:
  - .1 Review shop drawings, product data and samples prior to submission.
  - .2 Verify field measurements; field construction criteria; catalogue numbers; and similar data.
  - .3 Coordinate each submission with requirements of work and contract. Individual shop drawings will not be reviewed until all related drawings are available. The contractor shall submit all shop drawings specified in a section in one submission. Multiple shop drawing submissions for a specification section shall not be acceptable. In the event that shop drawings are submitted piecemeal (multiple submissions) within a specification section, the shop drawings shall be retained by the Consultant until all shop drawings from that section have been received for review.
  - .4 Contractor's responsibility for errors and omissions in submission is not relieved by Consultant's review of submittals.
  - .5 Contractor's responsibility for deviations in submission from requirements of contract documents is not relieved by Consultant's review of submission, unless Consultant gives written acceptance of specified deviations.
  - .6 Notify Consultant, in writing at time of submission, of deviations from requirements of contract documents.
  - .7 After Consultant's review, distribute copies.
- .5 Submission requirements:
  - .1 Schedule submissions at least 15 working days before dates reviewed submissions will be needed.
  - .2 Electronic shop drawing submissions are acceptable with the following conditions:
    - .1 The shop drawings are submitted in pdf format with a transmittal and include the contractor's review stamp.
    - .2 The page size cannot exceed 8.5"x11" and must be fully legible.

In the event that the electronic submission cannot conform to the requirements identified above, the Contractor shall submit six (6) sets of hard copies for review.
  - .3 On each submission sheet, ensure clear space 3" x 3" for review stamp (e.g. letter size data sheet on legal size paper).
  - .4 Accompany submissions with transmittal letter containing:

- .1 Date; project title and number; Contractor's name and address; number of each shop drawing, product data and sample submitted.
- .2 Other pertinent data.
- .5 Submissions shall include:
  - .1 Date and revision dates; project title and number.
  - .2 Name of: Contractor; sub-contractor; supplier; manufacturer.
  - .3 Identification of product or material.
  - .4 Relation to adjacent structure of materials.
  - .5 Field dimensions, clearly identified as such.
  - .6 Specification section numbers.
  - .7 Applicable standards, such as CSA or ULC listings.
  - .8 Contractor's stamp, initialled or signed, certifying review of submission, verification of field measurements and compliance with contract documents.

1.24 Maintenance  
Manuals

- .1 One draft copy of the proposed maintenance manual shall be submitted for review within four (4) weeks of the review of shop drawings.
- .2 The Consultant may withhold progress payments until such time as the draft copy is received.
- .3 Once the draft copy has been reviewed by the Consultant, submit to Consultant three (3) copies of Operating and Maintenance Data incorporating the revisions as necessary, made up as follows:
  - .1 Bind data in vinyl hard covered, 3 ring loose leaf binder for 215 x 280 mm size paper.
  - .2 Enclose title sheet, labelled "Operating and Maintenance Data Manual", project name, date and list of contents.
  - .3 Organize contents into applicable sections of work to parallel project specification breakdown. Mark each section by labelled tabs protected with celluloid covers fastened to hard paper dividing sheets.
- .4 Include following information plus data specified.
  - .1 Maintenance instruction for finished surface and materials.
  - .2 Copy of hardware and paint schedules.
  - .3 A clear copy of approved shop drawings for all equipment.

- .4 A schedule for all equipment summarizing the Reference Number, Make, Model, Capacity, Electrical Data, etc.
  - .5 Description, operation and maintenance instructions for equipment and systems, including complete list of equipment and parts list. Indicate nameplate information such as make, size, capacity, serial number.
  - .6 Names, addresses and phone number of sub-contractors and suppliers.
  - .7 Guarantees, warranties and bonds showing:
    - .1 Name and address of projects.
    - .2 Guarantee commencement date (date of Final Certificate of Completion).
    - .3 Duration of guarantee.
    - .4 Clear indication of what is being guaranteed and what remedial action will be taken under guarantee.
    - .5 Signature and seal of Contractor.
  - .8 Additional material used in project listed under various sections showing name of manufacturer and source of supply.
- .5 Neatly type lists and notes. Use clear drawings, diagrams or manufacturer's literature.

#### 1.25 Demolition

- .1 Full extent of demolition is not illustrated on drawings. Where indicated on the drawings and where walls and ceilings are shown to be removed, disconnect, cap, and remove all services and equipment. All services and equipment which have become redundant under the contract shall be removed.

All items removed during demolition shall be removed from the site, unless noted otherwise. All materials to be removed from site shall be disposed of in accordance with all Provincial codes and regulations. Consultant shall be notified if contractor is unsure of services to be removed or capped.
- .2 The Contractor shall remove and reinstate to match existing, any electrical items or services which interfere with demolition and new construction.
- .3 The Contractor is responsible for immediate reconnection of any services which are to remain and which have been disconnected during the course of demolition or construction.

- .4 All equipment to be re-used is to be cleaned of paint, plastic, etc. to the satisfaction of the Consultant.
- .5 Where indicated, panelboards are to be removed. Existing feeders from main panelboard to be maintained to feed new replacement panels. Make provisions to properly fasten existing feeder conduit to new panel tubs.
- .6 Contractor is responsible for reconnecting any existing loads which do not appear on panel details and which are to be re-used.
- .7 Where existing materials are to be re-used, the Contractor shall be responsible for their removal, storage, cleaning and reinstallation.
- .8 Turn over to the Owner any redundant existing material or equipment designated by the Owner or specified on drawings.
- .9 The Contractor shall be responsible for protecting all equipment and services to remain during the course of demolition. Should any damage occur, it shall be the Contractors responsibility to supply and install new services and equipment.
- .10 Maintain adequate structural support for equipment and material during demolition process.
- .11 It is the responsibility of this Contractor to maintain electrical services and systems at all times to areas beyond the construction area.
- .12 Retain continuity of service of the fire alarm system to all areas of the building.

1.26 Contractor  
Quality Assurance  
Program

- .1 The Contractor is solely responsible for the control, charge and supervision of construction methods, techniques, sequences and procedures, and for safety precautions and programs required in connection with the work.
- .2 The Contractor is responsible for the discovery and correction of deficiencies, errors and omissions in the execution and

performance of the work and for the preparation of submissions, reports, relating to the work.

- .3 The Contractor is responsible for providing the appropriate quality assurance program to ensure that the work is carried out and performs in accordance with the Contract Documents, industry standards and relevant codes and legislation. The Contractor Quality Assurance Program is to ensure the following:
  - .1 The use of qualified tradesmen, experts and professionals with the level of skill and experience required for the proper execution and performance of the work.
  - .2 The level of direction, supervision and inspection required for the proper execution and performance of the work.
  - .3 The level of co-ordination between trades, field conditions, material requirements and product requirements required for the proper execution and performance of the work.
  - .4 The level of management required for the quality assurance program to operate effectively so that deficiencies, errors and omissions in the work are identified by the Contractor on a continuous basis and that corrective action is carried out promptly.
  - .5 The level of management and communication required for the status of the work to be properly monitored and reported to the Owner and the Consultant.
- .4 Project observation reports of the work by the Consultant and Owner are not to be considered part of the Contractor Quality Assurance Program.
- .5 The review of Contractor prepared submissions (shop drawings, reports, etc.) by the Consultant and Owner are not to be considered part of the Contractor Quality Assurance Program, and do not alleviate the Contractors responsibility to meet all documented requirements.

#### 1.27 Progress Payments

- .1 Payment requests are to be submitted on a system by system, area by area, basis as per the agreed cost breakdown.
- .2 Date applications for payment for the last day of the monthly payment period and ensure amount claimed is for value proportionate to amount of Contract, of Work performed, and Products delivered to Place of Work at that date. Payment will not

be authorized for materials that are not delivered to site at date of submission of claim.

- .3 Payment for work that requires field testing, approval from authorities having jurisdiction, or approval from specified experts such as seismic control, will be limited to 90% of the value of the labour and material of such work until such time as the testing is completed, witnessed and recorded, the authorities having jurisdiction have given their approval for the work, or the specified experts have provided their written verification of the installations.
- .4 Payment for work that must prove performance through start-up, balancing and commissioning activities will be limited to 98% of the value of the labour and material for each system until such time as the equipment manufacturer's start-up tests are complete and reports submitted and the equipment is in satisfactory operation.
- .5 Payment against the Commissioning allowance will not commence until after the final balancing is complete, and will be paid in proportion to the completion of the defined commissioning activities.

#### 1.28 Substantial Performance

- .1 The Contractor's Application for Substantial Performance is to include documentation that supports the Contractor's certification that the work has been carried out and is performing in accordance with Contract Documents and is "ready for use for the purpose intended".
- .2 The following documentation is required on a system-by-system basis in conjunction with the Contractor's Progress Payment Request:
  - .1 Component and System Test Reports.
  - .2 Distribution System Balancing and Capacity Test Reports.
  - .3 Local Authority Inspection Reports (Building Inspection, Electrical Safety Authority Occupancy Inspection, etc.).
  - .4 Fire Alarm System Verification Reports (if fire alarm work is affected).
  - .5 Equipment Manufacturer Certification of Approval of Installation and Operation.
  - .6 Completion of Training activities to an extent which allows the Owner to undertake operation and maintenance of electrical systems.

- .7 Turnover of completed Record Drawings to the Owner.
- .8 Turnover of completed Maintenance Manuals to the Owner.
- .9 Turnover of specified spare parts.
- .10 Contractor's Warranty Certificate.
- .11 Product Manufacturer's Warranty and Extended Warranty Certificates.
- .12 Contractor's Report on work presently identified as being incomplete and the schedule to complete the work.
- .13 Report on work presently identified as being deficient and the schedule to carry out corrective work.
- .14 Report on Product Warranty start dates for work which is incomplete or Deficient.

END OF SECTION



## PART 1 – GENERAL

### 1.1 General Requirements

- .1 Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.

### 1.2 Definitions

- .1 "Provide" means supply, install and connect.
- .2 "Approved" means approved in writing by Consultant.
- .3 "Inspection Authority" means Electrical Safety Authority.
- .4 "Supply Authority" means Hydro One.
- .5 "Consultant" means the person or entity engaged by the Owner and identified as such in the Agreement. The Consultant is the Architect, the Engineer or entity licensed to practice in the province or territory of the Place of the Work.
- .6 "Manual" means Operations and Maintenance manual.
- .7 "Engineer" means Professional Engineer licensed to practice in the province or territory of the Place of the work with a Certificate of Authorization to provide professional engineering services to the public.

### 1.3 Operation and Maintenance Data

- .1 Provide operation and maintenance data for incorporation into Manual specified in Sections 00 and 01.
- .2 Include in operations and maintenance data:
  - .1 Details of design elements, construction features, component function and maintenance requirements, to permit effective start-up, operation, maintenance, repair, modification, extension and expansion of any portion or feature of installation.
  - .2 Technical data, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items, and parts lists. Advertising or sales literature not acceptable.
  - .3 Wiring and schematic diagrams and performance curves.

- |  |    |  |
|--|----|--|
| 1.4 Maintenance<br><u>Materials</u>              | .4 | Names and addresses of local suppliers for items included in maintenance manuals.  |
|  | .5 | As built panel schedules.  |
|  | .1 | Provide maintenance materials as called for in these specifications.   |
| 1.5 Seismic<br>Analysis<br><u>and Provisions</u> | .1 | Install electrical systems with adequate structural support to withstand seismic forces in accordance with Section 4.1.8 of the Ontario Building Code.   |
|  | .2 | Apply the following Importance Categories: Post-disaster for buildings intended for such usage including hospitals, High for schools, and Normal for all other building types, as referenced in 4.1.8.5 of the Ontario Building Code.  |
|  | .3 | All equipment shall be suitably anchored, whether rigidly connected to the structure, or on vibration isolators, and designed for earthquake loading for the Brockville area.  |
|  | .4 | Drilled or power driven anchors or fasteners not permitted for use with seismic control measures.  |
|  | .5 | No equipment, equipment supports or mounts to fail before failure of structure.  |
|  | .6 | Retain a Seismic Engineer licensed in the Province of Ontario to perform a review of the proposed electrical installation. Provide detailed shop drawings showing the required seismic supports, bracings and fastenings restraint system for all equipment and systems to be provided under the scope of the project. These documents shall be sealed and signed by the Seismic Engineer and submitted as part of the shop drawing package prior to rough-in work commencing on-site. The electrical contractor shall be solely responsible for the full scope of this work. Include all costs of seismic design, materials, and site review in tender bid. |
|  | .7 | In the event that seismic restraints are determined not to be necessary by the contractor's Seismic Engineer, a signed and sealed letter confirming this conclusion shall be provided by the contractor's Seismic Engineer and submitted for review.   |

- .8 Seismic control measures not to interfere with integrity of firestopping.
- .9 Static Equipment:
  - .1 Anchor equipment to equipment supports. Anchor equipment supports to structure.
  - .2 Suspended equipment shall be restrained using sway bracing and hanger rods. Equipment supported by vibration-isolation hangers shall be detailed and installed with isolation hangers close to the structure and upward limit stops located directly below the hangers. Avoid bracing equipment to separate portions of the structure that may act differently in response to an earthquake. For example, do not connect a transverse brace to a wall and a longitudinal brace to a floor or roof at the same brace location.
- .10 Vibration isolated equipment:
  - .1 Seismic control measures not to jeopardize noise and vibration isolation systems. Provide 6 to 9 mm clearance during normal operation of equipment and systems between seismic restraint and equipment.
  - .2 Incorporate seismic restraints into vibration isolation system to resist complete isolator unloading.
- .11 The Seismic Engineer providing the certified design for seismic control of equipment/components/systems shall visit the site as required to provide a letter at the end of construction indicating the installation is in accordance with the certified shop drawing submission and Ontario Building Code item 4.1.8.18 "Elements of Structures, Non-Structural Components and Equipment". The letter shall be stamped and signed, with the Professional Engineer's seal, licensed in the Province of Ontario. Should the equipment and systems provided under the scope of this project not require seismic restraint systems as determined by the Seismic Engineer, the Seismic Engineer providing the review shall provide a letter, stamped and signed, indicating that the installation does not require seismic restraints.
- .12 The electrical contractor shall be solely responsible for the full scope of this work. Include all costs of seismic design, materials, and site review in tender bid.

1.6 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, for special systems, e.g. fire alarm.
- .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

1.7 Voltage  
Ratings

- .1 Operating voltages: to CSA C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz. within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

1.8 Inspections

- .1 Furnish a Certificate of Acceptance from Inspection Authority on completion of work.

1.9 Materials  
and Equipment

- .1 Equipment and materials to be CSA certified, and manufactured to standard quoted.
- .2 Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Inspection Department.
- .3 Factory assemble control panels and component assemblies.

1.10 Electric  
Motors, Equipment  
and Controls

- .1 Provide motor controls as indicated on electrical drawings.

- .2 Refer to mechanical equipment schedules, or specifications, for further details on equipment supplied by mechanical trades. Obtain copy of each mechanical shop drawing, and co-ordinate electrical work to support all connections required. Bring discrepancies to attention of Consultant, and obtain ruling on resolution before installing services. No allowance will be made for corrections required due to failure to co-ordinate before installation.
- .3 Control wiring and conduit is by electrical contractor where indicated on electrical drawings; otherwise control wiring up to and including 120 volts is by mechanical contractor. Connect as indicated, or to suit wiring diagram supplied with equipment to make a complete, operating system.

#### 1.11 Finishes

- .1 Shop finish metal enclosure surfaces by removal of rust and scale, cleaning, application of rust resistant primer inside and outside, and at least two coats of finish enamel.
  - .1 Paint outdoor electrical equipment "equipment green" finish to EEMAC Y1-1.
  - .2 Paint indoor switchgear and distribution enclosures "light grey" to EEMAC 2Y-1.
- .2 Clean and touch up surfaces of shop painted equipment scratched or marred during shipment or installation, to match original paint.
- .3 Clean, prime and paint exposed hangers, racks, fastenings, to prevent rusting.

#### 1.12 Acoustical Performance

- .1 In general, provide equipment producing minimal sound levels in accordance with the best and latest practices established by the electrical industry.
- .2 Do not install any device or equipment containing a magnetic flux path metallic core, such as gas discharge lamp ballasts, dimmers, solenoid, etc., which are found to produce a noise level exceeding that of comparable available equipment.

1.13 Equipment  
Identification

- .1 Identify with lamicoid nameplates all electrical equipment shown on the drawings and/or mentioned in the specification such as switches, starters, panelboards, transformers, controls, and special receptacles, regardless of whether or not the electrical equipment was furnished under this section of the specification. Hand painted identification is not acceptable.
- .2 Coordinate names of equipment and systems with other Divisions to ensure that names and numbers match.
- .3 Wording on nameplates to be approved by the Consultant prior to fabrication.
- .4 Identification to be English.
- .5 Nameplates shall identify the equipment, the voltage characteristics, the power source for the equipment, and load being served (if applicable). Provide warning labels for equipment fed from two or more sources.
- .6 Unless otherwise specified, nameplates shall be rigid lamicoid, minimum 1.5 mm (1/16") thick with black letters engraved on a white background. For emergency power circuits, use a red background.
- .7 Mount nameplates using self-tapping 2.3 mm (3/32") diameter slot head screws, two per nameplate for nameplates under 75 mm (3") in height. A minimum of four (4) screws shall be used for larger nameplates. Other methods of attachment only with approval of Consultant.
- .8 All nameplates shall have a minimum border of 3 mm (1/8"). Characters shall be 9 mm (3/8") in size unless otherwise specified. Nameplates for receptacles and light switches shall have 6 mm (1/4") characters.
- .9 Provide neatly typed updated circuit directories in a plastic holder on the inside door of new panelboards, with copy in Manual.
- .10 Carefully update panelboard circuit directories whenever adding, deleting, or modifying existing circuitry, with a copy in Manual.
- .11 Identify all pull and junction boxes, with permanent handwritten marker identification of panel and circuits.

- .12 Where referenced in other Sections, provide nameplates of following sizes:

NAMEPLATE SIZES

Size 1 10 x 50 mm	1 line	3 mm high letters
Size 2 12 x 70 mm	1 line	5 mm high letters
Size 3 12 x 70 mm	2 lines	3 mm high letters
Size 4 20 x 90 mm	1 line	8 mm high letters
Size 5 20 x 90 mm	2 lines	5 mm high letters
Size 6 25 x 100 mm	1 line	12 mm high letters
Size 7 25 x 100 mm	2 lines	6 mm high letters

1.14 Wiring  
Identification

- .1 Identify wiring with permanent indelible identifying markings, using 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.

1.15 Conduit  
and Cable  
Identification

- .1 Colour code conduit system.
- .2 Code with paint on covers of junction boxes and condulets.
- .3 Colours to be
- .1 Fire Alarm: Red.
  - .2 Emergency Power: Yellow.
  - .3 Communication systems: Green.

1.16 Wiring

<u>Terminations</u>	.1	Lugs, terminals, screws used for termination of wiring to be suitable for 75 degree C rated conductors, either copper or aluminum. Where existing equipment is rated for less than 75 degree C, transition to lower temperature rating 1.5 meters from termination point using larger sized wire and conduit to suit.
<u>1.17 Manufacturers and CSA Labels</u>	.1	Ensure that manufacturer's registration plates are properly affixed to all apparatus showing the size, name of equipment, serial number, and all information usually provided, including voltage, cycle, phase and the name and address of the manufacturer.
	.2	Do not paint over registration plates or approval labels. Leave openings through insulation for viewing the plates. Contractors or sub-contractors nameplate not acceptable.
<u>1.18 Warning Signs and Protection</u>	.1	Provide warning signs, as specified or to meet requirements of Authorized Electrical Inspection Department and Consultant.
	.2	Accept the responsibility to protect those working on the project from any physical danger due to exposed live equipment such as panel mains, outlet wiring, etc. Shield and mark all live parts with the appropriate voltage. Caution notices shall be worded in English.
<u>1.19 Single Line Electrical Diagrams</u>	.1	Provide single line electrical diagrams in glazed frames as follows: .1 Electrical distribution system: locate in both main electrical rooms.
<u>1.20 Location of Outlets</u>	.1	Locate outlets as shown on drawings.
	.2	Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.
	.3	Change locations of outlets at no extra cost or credit, providing distance do not exceed 3 m, and information is given before installation.



- .4 Locate light switches on latch side of doors.
- .5 Outlets locations shown on drawings are approximate. Refer to architectural elevations, millwork, and equipment drawings for final locations and mounting height. No extra will be allowed for re-locations due to lack of co-ordination with all documents.

#### 1.21 Mounting Heights

- .1 Mounting height of equipment is from finished floor to centre line of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not indicated, verify before proceeding with installation.
- .3 Install electrical equipment at the following heights unless indicated otherwise:
  - Local Switches 1100 mm
  - Wall Receptacles:
  - General: 400 mm
  - In mechanical and electrical rooms: 1100 mm
  - Panelboards to top of trim: 1800 mm
  - Thermostats: 1200 mm

#### 1.22 Load Balance

- .1 Measure phase current to panelboards with normal loads operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases, record changes, and revise panel schedules.
- .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
- .3 Submit, at completion of work, a report listing phase and neutral currents on new or revised panelboards, dry-core transformers, and motor starters, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

#### 1.23 Conduit and Cable Installation

- .1 Install sleeves prior to pouring of concrete: sized for free passage of conduit, and protruding 50mm.

- .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.
- .3 All exposed conduits and raceways to be installed parallel to building lines.

#### 1.24 Firestopping

- .1 Where cables or conduits pass through floors and fire rated walls, pack space between wiring and sleeve full with firestopping system to CAN 4-S115.
- .2 Use only firestop products that have been ULC or cUL tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance. For those firestop applications that exist for which no ULC or cUL tested system is available through a manufacturer, then submit a manufacturer's engineering judgment derived from similar ULC or cUL system designs or other tests to local authorities having jurisdiction for their review and approval prior to installation. Engineered judgment drawings must follow requirements set forth by the International Firestop Council (September 7, 1994).
- .3 Cast-in place firestop devices are installed prior to concrete placement for use with non-combustible and combustible plastic pipe (closed and open piping systems) penetrating concrete floors, the following products are acceptable:
  - .1 Hilti CP 680 Cast-In Place Firestop Device
  - .2 Equivalent products listed in the U.L.C. Fire Resistance Directory - Volume III or UL Products Certified for Canada (cUL) Directory).
- .4 Sealant or caulking materials for use with non-combustible items including rigid steel conduit and electrical metallic tubing (EMT), the following products are acceptable:
  - .1 Hilti FS-ONE Intumescent Firestop Sealant
  - .2 Hilti CP 604 Self Leveling Firestop Sealant
  - .3 Hilti CP 620 Fire Foam
  - .4 3M Fire Stop Sealant 2000
  - .5 3M Fire Barrier CP25 WB
  - .6 Tremco Tremstop Fyre-Sil Sealant

- .7 Equivalent products listed in the U.L.C. Fire Resistance Directory - Volume III or UL Products Certified for Canada (cUL) Directory
- .5 Intumescent sealants or caulking materials for use with combustible items (penetrants consumed by high heat and flame) including PVC jacketed, flexible cable or cable bundles, the following products are acceptable.
  - .1 Hilti FS-ONE Intumescent Firestop Sealant
  - .2 Hilti CP 620 Fire Foam
  - .3 3M Fire Barrier CP25 WB
  - .4 Tremco Tremstop WBM Intumescent Firestop Sealant
  - .5 Equivalent products listed in the U.L.C. Fire Resistance Directory - Volume III or UL Products Certified for Canada (cUL) Directory
- .6 Intumescent sealants, caulking or putty materials for use with flexible cable or cable bundles, the following products are acceptable:
  - .1 Hilti FS-ONE Intumescent Firestop Sealant
  - .2 Hilti CP 618 Firestop Putty Stick
  - .3 Hilti CP 620 Fire Foam
  - .4 3M Fire Barrier CP25 WB
  - .5 Tremco Tremstop WBM Intumescent Firestop Sealant
  - .6 Equivalent products listed in the U.L.C. Fire Resistance Directory - Volume III or UL Products Certified for Canada (cUL) Directory
- .7 Non curing, re-penetrable intumescent sealants, caulking or putty materials for use with flexible cable or cable bundles, the following products are acceptable:
  - .1 Hilti CP 618 Firestop Putty Stick
  - .2 Equivalent products listed in the U.L.C. Fire Resistance Directory - Volume III or UL Products Certified for Canada (cUL) Directory
- .8 Wall opening protective materials for use with U.L.C listed metallic and specified nonmetallic outlet boxes, the following products are acceptable:
  - .1 Hilti CP 617 Firestop Putty Pad
  - .2 Equivalent products listed in the U.L.C. Fire Resistance Directory - Volume III or UL Products Certified for Canada (cUL) Directory

- .9 Materials used for large size/complex penetrations made to accommodate cable trays, electrical busways in raceways, the following products are acceptable:
  - .1 Hilti FS 635 Trowelable Firestop Compound
  - .2 Hilti FS 657 FIREBLOCK
  - .3 Hilti CP 620 Fire Foam
  - .4 3M Firestop Foam 2001
  - .5 3M Fire Barrier CS-195 Composite Sheet
  - .6 Equivalent products listed in the U.L.C Fire Resistance Directory - Volume III or UL Products Certified for Canada (cUL) Directory
- .10 Non curing, re-penetrable materials used for large size/complex penetrations made to accommodate cable trays, electrical busways in raceways, the following products are acceptable:
  - .1 Hilti FS 657 FIREBLOCK
  - .2 Equivalent products listed in the U.L.C Fire Resistance Directory - Volume III or UL Products Certified for Canada (cUL) Directory

#### 1.25 Tests

- .1 Conduct tests of the following:
  - .1 Power distribution system including phasing, voltage, grounding, insulation resistance, short circuit co-ordination, and load balancing.
  - .2 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
- .2 Furnish manufacturer's certificate or letter for each special system confirming that entire installation has been installed to manufacturer's instructions.
- .3 Carry out tests in presence of Consultant. Provide 72 hours notice of tests. Wherever tests are called for in these specifications, test results shall be recorded neatly on a form identifying the date and test completed together with the results and a copy shall be included in each maintenance manuals. Where a Commissioning Agent has been retained, the tests shall also be performed in his presence.
- .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .5 Refer also to the detailed specification articles where additional testing requirements are outlined.

1.26 Insulation  
Resistance Testing

- .1 Megger circuits, feeders and equipment up to 350V with a 500V instrument, and up to 600V with 1000V instrument.
- .2 Check resistance to ground before energizing, and ensure value meets levels of Table 24 of the Code. Make good any circuits which do not meet this standard.

1.27 Coordination  
of Protective  
Devices

- .1 Ensure circuit protective devices such as over current trips, relays, fuses, are installed to values and settings as indicated.

1.28 Motor Rotation

- .1 For new motors, ensure that motor rotation matches the requirements of the driven equipment.
- .2 For existing motors, check rotation before making wiring changes in order to ensure correct rotation upon completion of the job.

1.29 Cleaning

- .1 Do final cleaning in accordance with Sections 00 and 01.
- .2 At time of final cleaning, clean lighting reflectors, lenses, and other lighting surfaces that have been exposed to construction dust and dirt.

1.30 Access Doors

- .1 Supply access doors for furred ceilings or spaces for servicing equipment and accessories or for inspection of life safety or operating devices for installation by the General Contractor.
- .2 Access doors shall be flush mounted 600 x 600 mm for body entry, and 300 x 300 mm for hand entry, unless otherwise noted. Doors shall open 180 deg. have rounded safety corners, concealed hinges, screw-driver latches and anchor straps. Steel shall be prime coated.
- .3 Supply stainless steel access doors for tiled, marble, terrazzo or special surfaces.

- .4 Access doors in fire rated walls, ceilings and assemblies shall be ULC listed to suit the fire rating.
- .5 Acceptable Materials:
  - .1 Buensod
  - .2 Le Hage
  - .3 Zurn
  - .4 Alternate materials as approved by addendum in accordance with Instructions to Tenderers.

### 1.31 Temporary and Trial Usage

- .1 After approval by the Consultant, equipment shall be put into service for temporary or trial usage, at the discretion of the Consultant after it is mutually agreed that such use will not damage the equipment, create safety hazards nor void applicable guarantee.

### 1.32 Cooperation

- .1 Before commencing work, examine the contract drawings and schedules of all other trades. Report at once to the Consultant any interference which might affect the scheduling of, or performance of, work under this Division.
- .2 During construction, ensure that interference with the work of other trades is kept to a minimum and that the finished work of other trades is protected against damage from the electrical work.
- .3 Coordinate any opening or sleeves required for the installation of circuits or equipment so as not to interrupt the progress of masonry and concrete work.
- .4 Obtain approval from the Consultant, or from the Contractor responsible for structural members, before any openings are cut in structural supports, either concrete or steel.

### 1.33 Approval of Equivalent Products

- .1 Manufacturers and/or catalogue references of equipment considered acceptable are shown herein and on the drawings. During the tender period, any manufacturers wishing alternative products to be considered shall submit to the Consultant a written application for approval of the equivalent product. Approval of an equivalent

product shall be signified by the issuance of an appropriate addendum.

- .2 No substitutes will be allowed for equipment previously approved by the Consultant for the job unless it can be shown that unforeseen delays in delivery of such equipment are causing a substantial delay in the construction schedule. The Consultant reserves the right to review such substitutions and investigate the reasons for delay with the manufacturer before approval is given.

#### 1.34 Project Personnel

- .1 The project manager and site foreman assigned to this project shall be consistent from project start to project completion. No substitutions shall be permitted without written approval/acceptance from the Consultant and Owner.
- .2 A licensed journeyman electrician shall be present on site whenever the electrical contractor is performing work of any kind.

#### 1.35 Interference Drawings

- .1 The electrical contractor shall provide cooperation and assistance with the interference drawings which are to be produced by the mechanical contractor. Provide locations of all equipment, cable tray, lighting, and conduit complete with shop drawings for the mechanical contractor to aid in the preparation of the interference drawings.
- .2 The mechanical and electrical drawings are diagrammatic and do not show details at intersection of services. Re-routing required for the clearance of all services that results in additional elbows and fitting for piping, ductwork, conduit, and cable tray within a 1500 mm radius from the diagrammatic position will not be cause for additional payment. Exact locations of runs of piping, ducts, cable trays, and conduits shall be established by the contractor in cooperation with sub-trades and other contractors prior to installation so that they will clear each other and other obstructions. In general, piping requiring uniform pitch on horizontal runs shall be given the right of way. All surface mounted components and instrumentation devices shall be carefully coordinated with the Prime Consultant and no final locations for such surface mounted items shall be chosen except with the Prime Consultant's written approval.

1.36 Adhesives  
And Sealants

- .1 All adhesives and sealants used must be low volatile organic compound type to conform to LEED® Indoor Environmental Quality Credit - Low Emitting Materials, as specified in Sections 00 and 01.

1.37 Changes  
in the Work

- .1 Changes in the work may be requested from time to time by the issuance of a Contemplated Change Notice (CCN) and/or Proposed Change (PC). Refer to general conditions of the contract or front end specifications for requirements on how to quote changes in the work. Those requirements take precedence over the requirements following in this Section.
- .2 Should the bid form, general conditions of the contract, or front end specifications not address how to quote changes in the work, the requirements following in this Section shall apply.
- .3 Provide detailed breakdowns of material and labour with unit prices and extensions required for review of Contemplated Change Notices (CCN's) or Proposed Changes (PC's).
- .4 In addition to the net cost of the change, the Contractor shall be entitled to a 15% fee to cover overheads & profit on the work and a 10% fee to cover overheads and profit on sub-trades.
- .5 Required labour shall be evaluated based on published NECA Manual of Labour Units, current at time of tender closing, using the "normal" column. No other Job Factors shall be considered applicable.
- .6 The overhead percentage and use of NECA labour units indicated above includes the following:
  - .1 Insurance.
  - .2 Bonding.
  - .3 Financing and interest.
  - .4 Coordination with other trades.
  - .5 Salaries of any staff above that of working foremen employed directly on the work.
  - .6 Licenses and permits.
  - .7 Onsite timekeeping and scheduling.
  - .8 Rest periods.
  - .9 Electrical clean up beyond OCA recommended practice.



- .10 Material handling.
  - .11 Personal hygiene.
  - .12 Safety training.
  - .13 Job site safety talks.
  - .14 WHMIS information.
  - .15 Health and Safety Committee.
  - .16 Escalating site safety procedures.
  - .17 Garbage Bins.
  - .18 Shipping and deliveries.
  - .19 Project Management.
  - .20 Estimating.
  - .21 Special Cleaning.
  - .22 Special Handling / Storage.
  - .23 Equipment rentals for small tools.
  - .24 Equipment Start-up.
  - .25 Any other Non Productive Time items.
- .7 A single blended labour rate based on a crew of 1 working foreman and 4 journeymen shall be used for Normal working hours for the duration of the project and shall include the following:
- .1 Base rate, Vacation Pay and Statutory Holidays as per current collective agreement for unionized contractors.
  - .2 Union deductions for Benefits (Health & Welfare), Retail Sales Tax on Health & Welfare, Pension, and Union Funds.
  - .3 Local ECA deductions.
  - .4 Legislated Payroll Burdens for:
    - .1 Canada Pension Plan.
    - .2 Employment Insurance.
    - .3 Workplace Safety & Insurance Board
    - .4 Employer Health Tax.
    - .5 Personal Emergency Leave
  - .5 Local ECA guideline adders for:
    - .1 Expendable Small Tools (bits, blades, etc).
    - .2 Site Facilities (trailer, lunchroom, phone).
    - .3 Personal Protection Equipment (glasses, vests, fall protection, hearing).
    - .4 Parking as per Collective Agreement.
    - .5 Clean up as per recommended practice.
- .8 For Premium Night Shift (minimum three consecutive night shifts), use the Normal rate calculation with a 20% adder to Base Rate, Vacation Pay, Pension, and Health & Welfare Benefits.

- .9 For Overtime, use the Normal rate calculation with a 100% adder to Base Rate, Vacation Pay, Pension, and Health & Welfare Benefits.
- .10 Cost quotations shall be based on industry accepted costing methods. Wiring, conduit and similar commodity-type materials shall be based on current Trade Service Canadian Monitor Plus net pricing with a 30% discount applied. Submit supplier invoices for other types of material such as power distribution equipment, light fixtures, heating products, fire alarm components, etc.
- .11 The following job expenses shall be considered to be acceptable in certain pricing exercises:
  - .1 Bonding costs.
  - .2 Warranty costs based on 2% of the material & labour cost for the change.
  - .3 Drafting costs based on 2% of the labour cost for the change.
  - .4 Hoisting.
  - .5 Equipment rentals for large equipment.
  - .6 Core drilling.
  - .7 Travel in accordance with the applicable union agreement.
- .12 The Electrical Contractor shall submit a template proposed to be used for any CCN's/PC's as a formal shop drawing submission for review and recommended acceptance prior to any CCN's/PC's being issued.

#### 1.38 General

##### Review Declaration

- .1 Prior to time of occupancy permit application, submit the following items for review:
  - .1 Electrical Safety Authority Certificate of Inspection, for Occupancy or Final, with no deficiencies noted.
  - .2 Letter indicating systems have been seismically restrained in accordance with the OBC. Letter shall be authored, signed, and sealed by a Professional Seismic Engineer licensed in the province of Ontario.
  - .3 Ground continuity and resistance test report.
  - .4 Letter indicating recommended settings indicated in Protective Device Coordination and Arc Flash Study have been made. Letter shall be authored, signed, and sealed by a Professional Engineer licensed in the province of Ontario.

- .2 Submissions shall be complete with transmittals or cover letters signed by an appropriate skilled trade. The signatory shall be registered with Skilled Trades Ontario.
- .3 The project must be substantially complete and ready for its intended use. Energize, test and commission all systems. Ensure systems have been installed in accordance with the contract documents, manufacturer's recommendations, and industry standards as the case may be.

END OF SECTION



## PART 1 - GENERAL

### 1.1 General Requirements

- .1 Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.

### 1.2 Related Work

- .1 Wire and Cable: Section 26 05 21
- .2 Outlet Boxes: Section 26 05 32

## PART 2 - PRODUCTS

### 2.1 Materials

- .1 Pressure type wire connectors: with current carrying parts of copper sized to fit copper conductors as required.
- .2 Fixture type splicing connectors: with fixture type current carrying parts of copper sized to fit copper conductors 10 AWG or less.
- .3 Clamps or connectors for armoured cable, flexible conduit, as required.

## PART 3 - EXECUTION

### 3.1 Installation

- .1 Remove insulation carefully from ends of conductors and:
  - .1 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.
  - .2 Install fixture type connectors and tighten. Replace insulating cap.
  - .3 Install box connectors as required.

END OF SECTION



## PART 1 - GENERAL

- 1.1 General .1 In general the wiring is not indicated on the drawings for the different systems. The necessary wiring shall however be provided between all equipment and/or devices and the panels and/or relays to which they are referred to on drawings. In some cases, the panel identification is not given for each circuit but is shown for a particular area.

- 1.2 General Requirements .1 Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.

## PART 2 - PRODUCTS

- 2.1 Building Wires .1 Conductors: stranded for 10 AWG and larger.
- .2 Copper conductors, size as indicated, with 600V insulation.
- .1 RW 90 XLPE for branch wiring unless otherwise noted.
- .2 AF or approved equal for wiring in or through lighting fixtures.
- .3 Same as .2 above except RWU 90 for all outdoor circuits, and in conduits below lowest floor slab.
- .4 Minimum conductor size shall be #12 AWG for power, #16 AWG for controls and fire alarm.
- .5 Wire and conduit sizes shown are based on RW90 XLPE using 75 degree C ampacity ratings and are minimum sizes. Contractor responsible for wire and conduit sizes for other approved wires.
- .6 Colour code wiring for 3 phase non-isolated systems as follows:
- .1 Phase conductors: red, black, blue
- .2 Neutral conductors: white
- .3 Bonding to ground: green
- .4 Isolated bonding conductor: green with yellow stripe
- 2.2 TECK Cable .1 Cable: to CAN/CSA-C22.2 No. 131, multi-conductor type.
- .2 Conductors:
- .1 Grounding conductor: copper
- .2 Circuit conductors: copper, size as indicated.

- .3 Insulation:
  - .1 Chemically cross-lined thermosetting polyethylene rated type RW 90, 600V.
- .4 Inner jacket, Polyvinyl Chloride (PVC) material.
- .5 Armour: interlocking aluminum.
- .6 Overall covering: thermoplastic PVC material with improved LFS/LGE jacket for fire protection and low acid gas evolution, meeting requirements of Vertical Tray Fire Test to CSA C22.2No.0.3 with maximum flame travel of 1.2 m.
- .7 Fastenings:
  - .1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
  - .2 Channel type supports for two or more cables at 1500 mm centres.
  - .3 6 mm dia. threaded rods to support suspended channels.
  - .4 For single conductor cables, provide fastenings without ferrous loop around cables, to satisfaction of Consultant.
- .8 Connectors: watertight TECK 90 type only. AC90, flex, or other types of connectors not acceptable.

### 2.3 Armoured Cables

- .1 Conductors: insulated, copper, size as indicated.
- .2 Type: AC90.
- .3 Armour: interlocking type fabricated from aluminum strip.
- .4 Connectors: to suit.

## PART 3 - EXECUTION

### 3.1 Installation of Building Wires

- .1 Install wiring in conduit systems in accordance with Section 26 05 34 except where otherwise noted.
- .2 Install all service entrance and panel feeder circuits without break or splice.



- .3 Install branch wiring without break or splice in new construction. In renovations, keep splices to absolute minimum.
- .4 Size wires for 3% maximum voltage drop to farthest outlet based on a fully loaded circuit.
- .5 In 120/208V branch circuits supplying power receptacles, the common neutral conductor of each 3 circuits or 2 circuit group shall be 1 size larger than the ungrounded conductors until the first 2 of 3 or 1 of 2 circuits have been dropped off.

3.2 Installation  
of TECK Cable  
0 - 1000V

- .1 Install cables only where indicated on plans or for flexible connections to motors. Do not use in air plenums.
- .2 Group cables wherever possible on channels.
- .3 Terminate cables in accordance with Section 26 05 20.

3.3 Installation  
of Armoured Cables

- .1 Group cables wherever possible.
- .2 Use only for:
  - .1 Vertical branch wiring within walls or for interconnection of ceiling fixtures, maximum length 4 meters.
  - .2 Horizontal branch wiring within walls to interconnect adjacent devices, maximum length 1 meter.
- .3 Terminate cable in accordance with Section 26 05 20.

END OF SECTION



## PART 1 - GENERAL

### 1.1 General Requirements

- .1 Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.

### 1.2 Reference Standards

- .1 Do grounding work to CSA C22.2 No.0.4 except where specified otherwise.

## PART 2 - PRODUCTS

### 2.1 Materials

- .1 Rod electrodes: copper clad steel, 19 mm diameter by 3 m long. Minimum quantity four (4).
- .2 Conductors: bare, stranded, tinned soft annealed copper wire, for ground bus, electrode interconnections. Minimum size 4/0 AWG.
- .3 Wire connectors and terminations: as indicated.
- .4 Accessories: non-corroding, necessary for complete grounding system, type, size material as indicated, including:
  - .1 Grounding and bonding bushings.
  - .2 Protective type clamps.
  - .3 Bonding jumpers, straps.
  - .4 Pressure wire connectors.
  - .5 Burndy Hyground system compression connections or thermit welded type conductor connectors where buried.

## PART 3 - EXECUTION

### 3.1 Grounding Installation

- .1 Install continuous grounding system including, electrodes, conductors, connectors, accessories, to requirements of Supply Authority and Inspection Authority. Installation to be in accordance with OESC Bulletin 36-10-XX (latest edition) requirements for tamper resistant pad mounted equipment.
- .2 Install connectors to manufacturer's instructions.

- .3 Protect exposed grounding conductors from mechanical injury.
- .4 Make buried connections, and connections to electrodes, structural steel work, using copper welding by thermit process or compression system by Burndy Hyground.
- .5 Use mechanical connectors for grounding connections to equipment provided with lugs.

### 3.2 Electrode Installation

- .1 Install ground rod electrodes, minimum 4, not less than 3 m apart. Make grounding connections to station equipment.
- .2 Make special provision for installing electrodes that will give acceptable resistance to ground value, where rock or sand terrain prevails.

### 3.3 Equipment Grounding

- .1 Install grounding connections as indicated to typical station equipment including: transformer, neutral, non current carrying parts of transformers, gang-operated switches, cable sheaths, raceways, meter and relay cases, metal forming part of station enclosure.
- .2 Ground hinged doors to main frame of electrical equipment enclosure with flexible jumper.

### 3.4 Cable Sheath Grounding

- .1 Bond single conductor, metallic sheathed cables together at one end only. Break sheath continuity by inserting insulating sleeves in cables.
- .2 Use No. 6 AWG flexible copper wire soldered, not clamped, to cable sheath.
- .3 Connect bonded cables to ground with No. 4/0 AWG copper conductor.

3.5 Tests

- .1 Perform tests in accordance with Section 26 05 00.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Consultant and Inspection Authority.
- .3 Submit test results and inspection certificates Consultant for review prior to energizing electrical system.

END OF SECTION



## PART 1 - GENERAL

### 1.1 General Requirements

- .1 Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.

## PART 2 - PRODUCTS

### 2.1 Materials

- .1 Grounding equipment: to CSA C22.2No.41.
- .2 Copper grounding and bonding conductors to: ASA G7.1.

### 2.2 Equipment

- .1 Clamps for grounding of conductors, size as required to electrically conductive underground water pipe.
- .2 Rod electrodes, copper clad steel 19 mm dia. by 3 m long.
- .3 Insulated grounding and bonding conductors to Section 26 05 21, green insulation, or green taped at all accessible locations.
- .4 Ground bus: 50 mm x 6 mm copper, 600 mm long, complete with insulated supports, fastenings, connectors.
- .5 Non-corroding accessories necessary for grounding system, including but not limited to:
  - .1 Grounding and bonding bushings.
  - .2 Bolted type conductor connections.
  - .3 Bonding jumpers, straps.
  - .4 Pressure wire connectors.
  - .5 Burndy Hyground system compression connections or thermit welded type conductor connectors where buried.

## PART 3 - EXECUTION

### 3.1 Installation General

- .1 Install complete permanent, continuous, system and circuit, equipment grounding systems including new rod electrodes, conductors, connectors, accessories, as indicated, and to conform to requirements of Inspection Authority.

- .2 Run a separate green insulated bonding conductor in all EMT conduits, including those feeding toggle switches and receptacles. Provide a minimum of one bonding conductor per group of three ungrounded phase conductors. Conduit not to be used as a bonding system.
- .3 Install connectors to manufacturer's instructions.
- .4 For 120/208V branch circuits, the bonding conductor shall be the same size and ampacity as the ungrounded conductors.
- .5 Protect exposed grounding and bonding conductors from mechanical injury.
- .6 Make buried connections, using copper welding by thermit process or using compression by Burndy Hyground system.
- .7 Use mechanical connectors for grounding and bonding connections where equipment comes equipped with lugs.
- .8 Use compression connectors with manufacturer's recommended tools, dies, and oxide inhibiting electrical joint compound to conductive water main or where equipment is not provided with lugs for connection.
- .9 Soldered joints not permitted.
- .10 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.
- .11 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.
- .12 Make grounding and bonding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connection.

3.2 Equipment  
Grounding and  
Bonding

- .1 Install grounding and bonding connections to equipment as shown and as required by Code.



3.3 Tests

- .1 Perform tests in accordance with Section 26 05 00 and submit results to Consultant before energizing electrical system.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Consultant and local authority having jurisdiction over installation.
- .3 Disconnect ground fault indicator during tests.

END OF SECTION



## PART 1 - GENERAL

### 1.1 General Requirements

- .1 Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.

## PART 2 - PRODUCTS

### 2.1 Support Channels

- .1 U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted or suspended as indicated.
- .2 Smaller sections subject to Consultant's approval.
- .3 Hot dipped galvanized.

## PART 3 - EXECUTION

### 3.1 Installation

- .1 Secure equipment to tile and plaster surfaces with quality nylon anchors, with independent grip protrusions.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.
- .5 Support equipment, conduit or cables using clips, spring loaded bolts, or cable clamps designed as accessories to basic channel members.
- .6 Fasten exposed conduit or cables to support system using straps.
  - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
  - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
  - .3 Beam clamps to secure conduit to exposed steel work.
- .7 Suspended support systems.

- .1 Support individual cable or conduit runs with 6 mm dia. threaded rods and spring clips.
- .2 Support 4 or more cables or conduits on channels supported by 6 mm dia. threaded rod hangers where direct fastening to building construction is impractical.
- .3 Trim excess threaded rod such that maximum 25mm protrudes beyond nut.
- .8 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .9 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .10 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .11 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Consultant.
- .12 Support from building structure where possible. Do not fasten to or support from metal roofing deck.
- .13 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.
- .14 All cut ends exposing base material to be completely sealed with field applied coating to give equivalent protection to hot dipped galvanized prior to installation. Following complete installation, all damage to protective layer to be carefully and completely touched up with same field applied coating.

END OF SECTION

## PART 1 - GENERAL

### 1.1 General Requirements

- .1 Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.

## PART 2 - PRODUCTS

### 2.1 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 two spare terminals on each set of lugs in splitters less than 400A.

### 2.2 Junction and Pull Boxes

- .1 Welded steel construction with screw-on flat covers for surface mounting.
- .2 Covers with 25 mm minimum extension all around, for flush-mounted pull and junction boxes.

### 2.3 Fire Rating

- .1 Boxes and cabinets installed in fire rated walls, ceilings and assemblies shall be ULC listed or suitably fire stopped to suit the fire rating.

## PART 3 - EXECUTION

### 3.1 Splitter Installation

- .1 Install splitters as indicated and mount plumb, true and square to the building lines.
- .2 Extend splitters full length of equipment arrangement except where indicated otherwise.

### 3.2 Junction,

Pull Boxes and  
Cabinets  
Installation

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Only main junction and pull boxes are indicated. Provide pull boxes so as not to exceed Code requirements between pull boxes.

END OF SECTION

## PART 1 - GENERAL

### 1.1 General Requirements

- .1 Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.

## PART 2 - PRODUCTS

### 2.1 Outlet and Conduit Boxes General

- .1 Size boxes in accordance with Ontario Electrical Safety Code Section 12 for number and size of conductors installed. Use of extension boxes is prohibited, except where used to extend for surface conduit distribution or by special permission from the Consultant.
- .2 102 mm square or larger outlet boxes as required for special devices.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 347V outlet boxes for 347V 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 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side.
- .2 102 mm square or octagonal outlet boxes for lighting fixture outlets.
- .3 102 mm square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster or tile walls.

2.3 Masonry  
Boxes

- .1 Electro-galvanized steel masonry single and multi gang boxes for devices flush mounted in exposed block walls.

2.4 Concrete  
Boxes

- .1 Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.5 Conduit Boxes

- .1 Cast FS or FD feraloy boxes with factory-threaded hubs and mounting feet for outdoor surface wiring of switches and receptacles.
- .2 Electro-galvanized utility type for indoor surface wiring.

2.6 Fittings -  
General

- .1 Bushing and connectors with smooth throats.
- .2 Knock-out fillers to prevent entry of foreign materials.
- .3 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

2.7 Fire Rating

- .1 Boxes installed in fire rated walls, ceilings and assemblies shall be ULC listed or suitably fire stopped to suit the fire rating.

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 construction material.
- .3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.



- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.
- .5 Extension rings or boxes are not allowed unless necessary to connect to an existing encased or embedded enclosure or box.

END OF SECTION



## PART 1 - GENERAL

### 1.1 General Requirements

- .1 Conform with requirements of front-end Sections 00 and 01 as they apply to the work of this discipline.

### 1.2 Location of Conduit

- .1 Drawings do not show all conduits. Those shown are in diagrammatic form only.
- .2 All conduits under floor slab shall be zoned in groups and run in as straight a line as possible.

## PART 2 - PRODUCTS

### 2.1 Conduits

- .1 Rigid metal conduit: to CSA C22.2 No. 45, galvanized steel, threaded, size as indicated.
- .2 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, size as indicated.
- .3 Rigid PVC conduit: to CSA C22.2 No.211.2, size as indicated.
- .4 Flexible metal conduit: to CSA C22.2 No. 56, steel core hot dipped galvanized, CSA listed, size as required.
- .5 Liquid-tight flexible metal conduit: to CSA C22.2 No. 56, steel core hot dipped galvanized, CSA listed, PVC jacket, FT-4 rated, size as required.
- .6 Epoxy coated conduit: to CSA C22.2 No. 45, with zinc coating and corrosion resistant epoxy finish, size as indicated.

### 2.2 Conduit Fastenings

- .1 One hole steel straps to secure surface conduits 50 mm and smaller. Two hole steel straps for conduits larger than 50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for four or more conduits at spacing required by code.

- .4 6 mm diameter threaded rods to support suspended channels.

### 2.3 Conduit Fittings

- .1 Fittings for raceways: to CSA C22.2 No.18.2 and No.18.3.
- .2 Fittings to be suitably sized for conduit used. Fittings used with EMT to be steel set-screw type, not cast.
- .3 Factory "ells" where 90 deg. bends are required for 25 mm and larger conduits, or field bends with approved hydraulic bender.

### 2.4 Expansion Fittings for Rigid Conduit

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 100 or 200 mm linear expansion as required.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection in all directions as indicated.

## PART 3 - EXECUTION

### 3.1 General

- .1 Refer to drawings for conduit sizes. Where not indicated, size as required by the OESC but 21 mm minimum. Run parallel or perpendicular to building lines unless specifically indicated otherwise.

### 3.2 Installation

- .1 Do not install conduits in poured concrete unless otherwise noted.
- .2 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .3 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.
- .4 Except where otherwise noted, conduits shall be as follows:
  - .1 For indoor distribution and wiring:
    - .1 Under slabs at grade: rigid galvanized steel or rigid PVC, complete with ground wire.

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- .2 In all other cases: EMT complete with ground wire.
- .2 Exterior, underground branch circuit wiring:
  - .1 Rigid PVC complete with ground wire for power circuits.
- .3 Conduit connections to dry type transformers:
  - .1 Flexible metal conduit complete with ground wire, maximum 1 meter.
- .4 Conduit connections to other vibrating equipment:
  - .1 Liquid tight flexible metal conduit complete with ground wire, maximum 1 meter.
- .5 For all other systems:
  - .1 Use EMT with separate ground wire.
- .5 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .6 Mechanically bend steel conduit over 21 mm diameter.
- .7 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .8 Install polypropylene fish cord in empty conduits.
- .9 Where conduits become blocked, remove and replace blocked section.
- .10 Provide wiring connection within junction box for any transition from EMT conduit to armoured cable (BX).
- .11 Ream and bush all conduit ends with nylon fittings.
- .12 Dry conduits out before installing wire.

### 3.3 Surface Conduits

- .1 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .2 Install conduits in flanged portion of structural steel.
- .3 Group conduits wherever possible on suspended or surface channels.

- .4 Do not pass conduits through structural members except as indicated.
- .5 Do not locate conduits less than 75 mm parallel to steam or hot water lines with a minimum of 25 mm at crossovers.
- .6 Do not fasten to or penetrate metal roofing deck or other similar weatherproof surfaces or assemblies.

3.4 Concealed  
Conduits

- .1 Do not install horizontal runs in masonry walls.
- .2 Do not install conduits in terrazzo or concrete toppings.

END OF SECTION

## PART 1 - GENERAL

### 1.1 Related Work Specified Elsewhere

- .1 Electrical - General Provision Section 26 05 00.
- .2 Grounding - Section 26 05 28.

### 1.2 References

- .1 CAN/CSA-G40.21, Structural Quality Steels.
- .2 EEMAC G1-1, Indoor and Outdoor Switch and Bus Insulators.

### 1.3 Description of System

- .1 Indoor unit substation with:
  - .1 Primary switchgear
  - .2 Transformer

### 1.4 Shop Drawings

- .1 Submit shop drawings in accordance with Section 26 05 00.
- .2 Indicate:
  - .1 Flow and wiring method.
  - .2 Dimensioned foundation template.
  - .3 Dimensioned cable entrance and exit locations.
  - .4 Dimensioned cable termination heights.

### 1.5 Source Quality Control

- .1 Substation manufactured and factory assembled by one supplier.

### 1.6 Operation and Maintenance Manuals

- .1 As soon as possible, but not later than the delivery date of the equipment, the supplier shall provide the electrical contractor with three (3) copies of operation and maintenance manuals, including the following:
  - .1 All shop drawings.
  - .2 Installation instruction of all components.
  - .3 Operating instructions.
  - .4 Instructions concerning maintenance.
  - .5 List of replacement parts.
- .2 These documents shall be incorporated in hard cover binders, the front covers shall indicate the name of the project, the Owner, Consultants and documents included.

1.7 Protection  
of Equipment

- .1 Protect equipment against damages of any form during transit.
- .2 Protect equipment and interior components from possible deterioration such as corrosion during storage and/or before it can be energized.

PART 2 - PRODUCTS

2.1 Materials

- .1 Unit substation: to NEMA 210.
- .2 Steel for cubicles: to CSA G40.21.
- .3 Insulators: to EEMAC G1-1.

2.2 Primary  
Switchgear

- .1 Primary switchgear: indoor 15 kV, 200A, 3 phase, 4 wire, interrupting capacity to suit available Utility fault (minimum 50kA), BIL 150 kV.

2.3 Primary  
Enclosure

- .1 Primary enclosure: metal enclosed free standing, floor mounted, dead front, indoor tamperproof CSA enclosure, cubicle unit. Constructed from rolled flat steel sheets 11 gauge thick.
- .2 Bottom entry for incoming primary cables.
- .3 Ventilating louvres: vermin proof with easily replaceable fibreglass filters.
- .4 Use non-corrodible bolts and hardware.
- .5 Access from front and back.
- .6 100 mm steel channel sills for base mounting.
- .7 Full height outer door reinforced with stiffeners, gasketed, hinges, provision for multiple padlocking. Three point latch, stops, to open at least 135 deg. with viewing windows of transparent shatterproof material or inspection of disconnecting switch position.
- .8 Inner door to open at least 90 deg.
- .9 Gaskets on removable covers.



- .10 Removable cover bolts not accessible from outside of cubicle.
- .11 Interior hinged and bolted mesh steel screens to prevent inadvertent contact with exposed live parts.
- .12 Storage container on inside surface of compartment to accommodate 3 spare fuse refills.

#### 2.4 Bus Bars and Connections

- .1 Three phase and full capacity neutral insulated bus bars, continuous current rating 200A extending full width of cubicle suitably supported on insulators.
- .2 Main connections between bus bars, major switching component and fuses of continuous current rating to match major switching components.
- .3 High conductivity copper for bus bars and main connections.
- .4 Brace bus-bar system to withstand stresses resulting from short circuit currents specified.
- .5 Tin surfaced joints, secured with non-corrosive bolts and washers, tightened with torque wrench in accordance with manufacturer's recommended load.
- .6 Identify phases of bus bars by suitable marking.
- .7 Bus bar connectors when switchgear shipped in more than one section.

#### 2.5 Grounding

- .1 Copper ground bus not smaller than 50 x 6 mm extending full width of multi-cubicle switchboard section and situated at bottom. Lugs at each end for size 3/0 AWG grounding cable.
- .2 Bond non current carrying metal parts, including switchgear framework, enclosure and bases to ground bus.

#### 2.6 Load Interrupter Switch

- .1 Three pole, quick-make, quick-break assembly, stored energy operating mechanism manual operated.

	.2	Continuous full load rating: 200A, interrupting rating: 50,000A, symmetrical.
	.3	Voltage rating: 15 kV.
	.4	Interphase barriers.
	.5	Fixed operating handle.
	.6	Power fuses: Bayonet type in series with current limiting fuses, nominally 45 amp, sizing to be coordinated with Utility.
<u>2.7 Lightning Arresters</u>	.1	Intermediate class.
<u>2.8 Transformer</u>	.1	Type: KNAN, FR3 filled.
	.2	CAN/CSA-C802.1-23 compliant.
	.3	Rating: 500 kVA, 3 phase, 60 Hz.
	.4	65 deg. C. temperature rise.
	.5	Impedance: 5% minimum.
	.6	Primary winding: 8.32 kV, delta configuration, BIL 75 kV.
	.7	Secondary winding: 120/208V, star, four wire with neutral brought out and effectively grounded.
	.8	No load losses not to exceed 0.4% of kW rating.
	.9	Full load losses not to exceed 1.6% of kW rating.
<u>2.9 Transformer Cubicles</u>	.1	Match primary switchgear enclosures construction.
	.2	Vents, front and back, and bottom, to provide adequate cooling for transformer.
	.3	Mount winding temperature measuring devices on front panel.

### 2.10 Finishes

- .1 Cubicle exteriors: gray.
- .2 Cubicle interiors: white.
- .3 Supply 2 spray cans touch up paint.

### 2.11 Equipment Identification

- .1 Provide equipment identification.
- .2 Nameplates:
  - .1 Primary switchgear-white plate, black letters, size 7:
    - .1 Engraved: "Primary Cubicle".
    - .2 Engraved: "Main Switch".
- .2 Transformer Section: white plate, black letters, size 7:
  - .1 Engraved: "Transformer" "+ 500 kVA, 8.32 kV to 120/208V, 3 phase, 60 Hz".
  - .2 Winding temperature device engraved: "Winding Temperature".

### 2.12 Acceptable Manufacturers

- .1 Eaton / Cooper
- .2 Siemens
- .3 Square D
- .4 Commercial Switchgear
- .5 Alternate materials as approved by addendum in accordance with General Instructions.

## PART 3 - EXECUTION

### 3.1 Installation

- .1 Set and secure cubicles in place, rigid and square on channel. Bolt to floor.
- .2 Connect to loads.
- .4 Run grounding conductor from unit bus to main ground bus.

- .5 Install as per manufacturer's recommendations.

3.2 Field  
Quality Control

- .1 Provide assistance for site commissioning.
- .2 Test for 24 consecutive hours, to include:
  - .1 Primary and secondary voltage at no load.
  - .2 Primary and secondary voltages at normal load once per hour.
  - .3 Primary and secondary current in each phase once per hour.
  - .4 kW and kVA once per hour.
  - .5 Transformer and ambient temperature once per hour.

3.3 Testing

- .1 Coordinate with supplier and ensure that testing has been done.
- .2 Place substations in service.

END OF SECTION

## PART 1 - GENERAL

### 1.1 General Requirements

- .1 Conform with requirements of front end Sections 00 and 01 as they apply to the work of this discipline.

### 1.2 Shop Drawings

- .1 Submit shop drawings in accordance with Section 26 05 00.
- .2 Indicate:
  - .1 Dimensioned positions of mounting devices.
  - .2 Dimensioned positions of terminations.
  - .3 Identified internal and external component layout on assembly drawing.
  - .4 Insulating liquid capacity.

### 1.3 Maintenance Data

- .1 Provide maintenance data for liquid cooled transformers for incorporation into manual specified in Section 26 05 00.
- .2 Include insulating liquid maintenance data.

## PART 2 - PRODUCTS

### 2.1 Transformer Characteristics

- .1 Transformers: to CSA C227.4 – Three-Phase Dead Front Pad-Mounted Distribution Transformers and CSA C88-16-Power Transformers and reactors and compliant with OESC Bulletin 36-15-XX (latest edition) – High voltage equipment standards.
- .2 Liquid cooled, three phase, outdoor, distribution transformers type KNAN, pad mounted, tamperproof lockable enclosure.
- .3 Primary voltage: 44000V, 60 Hz. delta connected, 3 phase, 3 wire.
- .4 Secondary voltage: 8.32/4.8 kV as indicated, wye connected, 3 phase, 4 wire, grounded neutral.
- .5 Capacity: 1000 kVA.

- .6 Basic impulse level: 250 kV.
- .7 Impedance: not less than 5% or more than 6%.
- .8 Coil materials: copper
- .9 Efficiency per CAN/CSA C802.3

## 2.2 High Voltage Bushings and Terminals

- .1 46 KV radial feed deadfront. Bushing style to be 200 amp rated large interface load-break separable type.

## 2.3 Low Voltage Bushings and Terminals

- .1 15 KV radial feed deadfront. Bushing style to be 200 amp rated large interface load-break separable type.

## 2.4 Mounting

- .1 Transformer suitable for mounting on concrete base and pad.
- .2 Base equal to USI E-37 6' x 12' precast switching manhole complete with USI E-13PS precast pad.

## 2.5 Voltage Taps

- .1 Four 2.5% taps, 2 FCAN, 2 FCBN.

## 2.6 Tap Changer

- .1 Externally operated off-load tap changer. 125 Amp, 5-position 250KV BIL, padlockable.

## 2.7 Insulating Liquid

- .1 Insulating liquid: FR3 non-PCB or equivalent, non-mineral oil.

2.8 Accessories

- .1 Hanger irons and adapter plates.
- .2 Liquid Celsius temperature thermometer, maximum indicating type, dial size 75 mm.
- .3 Liquid level gauge.
- .4 Top non-flammable insulating liquid sampling device.
- .5 Pressure vacuum gauge.
- .6 Pressure relief device.
- .7 25 mm drain valve with plug.
- .8 Set of (3) lightning arresters.
- .9 All factory installed, not field installed.

2.9 Finish

- .1 Finish tank exterior in accordance with Section 26 05 00 - Electrical General Provisions.

2.10 Bollards

- .1 Concrete filled steel bollard protective posts where shown, minimum four. Posts to be 6" (150 mm) diameter buried 60" (1500 mm) in 18" (450 mm) diameter concrete base, with smooth rounded concrete top, with rust bond primer and 2 coats outdoor safety yellow enamel, unless noted. Bollards to be supplied and installed by contractor.

2.11 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 00 - Electrical General Provisions.

2.12 Acceptable Manufacturers

- .1 Eaton
- .2 Schneider
- .3 Pioneer
- .4 PTI
- .5 CES

## PART 3 – EXECUTION

### 3.1 Production Testing

- .1 Unit shall be factory tested for the following:
  - .1 No-Load (85 °C or 20 °C) losses at rated current
  - .2 Total (85 °C) losses at rated current
  - .3 Percent Impedance (85 °C) at rated current
  - .4 Excitation current (100% voltage) test
  - .5 Winding resistance measurement tests
  - .6 Ratio tests using all tap settings
  - .7 Polarity and phase relation tests
  - .8 Induced potential tests
  - .9 Full wave and reduced wave impulse test
- .2 Submit satisfactory factory test certificate signed by manufacturer's authorized representative prior to shipping.

### 3.2 Installation

- .1 Ship transformers complete with first fill of liquid and pressurized with inert gas.
- .2 Install transformers only after other work in area is completed and in accordance with manufacturer's instructions. Locate minimum 6 meters from building envelope.
- .3 Install on manhole and pad per manufacturer's recommendations.
- .4 Use spreader bars on slings when lifting transformers into place.
- .5 Set and secure transformers in place rigid, plumb, square.
- .6 Ensure internal connections are mechanically tight.
- .7 Make connections.
- .8 Connect transformer ground terminal to system ground.
- .9 Fill transformers when required with metal hose and ensure care is taken to prevent contamination of liquid and components.
- .10 Set taps to produce rated secondary voltage at no load.

END OF SECTION



## PART 1 - GENERAL

### 1.1 General Requirements

- .1 Conform with requirements of front end Sections 00 and 01 as they apply to the work of this discipline.

### 1.2 Shop Drawings and Product Data

- .1 Submit shop drawings and product data in accordance with Section 26 05 00.
- .2 Indicate:
  - .1 Floor anchoring method and foundation template.
  - .2 Dimensioned cable entry and exit locations.
  - .3 Dimensioned position and type of bus.
  - .4 Overall length, height and depth of complete switchboard.
  - .5 Dimensioned layout of internal and front panel mounted components.

### 1.3 Maintenance Data

- .1 Provide data for incorporation into maintenance manual specified in Section 26 05 00.

## PART 2 - PRODUCTS

### 2.1 Materials

- .1 Switchboard assembly: to CSA C22.2 No.31, EEMAC G8-3.3.

### 2.2 Rating

- .1 Secondary switchboard: indoor 120/208V 3 phase, 4 wire, 60 Hz., current rating as shown, built to withstand a short circuit current of at least 35 kA (rms symmetrical) unless noted.

### 2.3 Enclosure

- .1 Enclosure
  - .1 Main incoming section to contain:
    - .1 Main breaker sized as indicated.
    - .2 Customer digital check meter with combined function LCD display, RS232C port for computer communication and appropriate BACNET software interface to support tie-in with Building Automation System.

- Provide all hardware and software programming as required for compatibility with the communication protocol used by the chosen BAS vendor; co-ordinate with BAS vendor as required.
- .3 Check meter shall be complete with non-volatile memory and reset functions for maximum and minimum since last reset to measure true RMS values, and shall indicate:
    - .1 each line current
    - .2 total current
    - .3 each phase to phase voltage
    - .4 each phase to neutral voltage
    - .5 power consumption in kilowatt-hours
    - .6 instantaneous and peak demand in kilowatts
    - .7 instantaneous and peak demand in kVA
    - .8 power factor
    - .9 frequency
    - .10 Total Harmonic Distortion (%) current & voltage each phase and 3 phase total
    - .11 K-Factor - each phase
  - .2 Distribution sections to contain:
    - .1 Feeder breakers as shown.
    - .2 High conductivity 99.30% copper bus and main connections, from main section to distribution sections including vertical bussing.
    - .4 Blanked off spaces for future units.
  - .3 Metering section between main breaker and distribution section, with provision for metering CT's and PT's as required, to suit Supply Authority. Co-ordinate with Supply Authority for exact requirements.
- .2 Metal enclosed free standing floor mounted, dead front, indoor completely tamperproof, sprinkler proof, CSA Type 1 enclosure. Bulkhead style including sides, top, doors, bottom enclosing plate, sills, horizontal and vertical barriers, lintels, supports, reinforcing member; formed, welded and braced into rigid self-supporting structure. Constructed from rolled flat steel sheets.
  - .3 Cubicle units to have adequate bracing, sufficient volume, and ventilating openings to prevent distortion of unit during normal operation and during circuit breaker operation under short circuit conditions, or when attempting breaker closure onto fault.

- .4 Remove burrs and sharp edges from steel work.
- .5 Use non-corrosive bolts and hardware.
- .6 100 mm steel channel sills for base mounting.

#### 2.4 Bus Bars

- .1 Three phase and full capacity neutral bare bus bars, continuous current rating as shown, self-cooled, extending full width of cubicle suitably supported on insulators. Bus to extend full height of enclosure such that each space is ready to accommodate future breaker whether indicated elsewhere in the contract documents or not.
- .2 Main connections between bus and major switching components, to have continuous current rating to match major switching components.
- .3 Brace bus bar system to withstand stresses resulting from specified short circuit currents.
- .4 Silver or tin surfaced joints, secured with non-corrosive bolts and Belleville washers, tightened with torque wrench to manufacturer's recommended load.
- .5 Identify phases of bus bars by suitable marking.
- .6 Bus bar connectors and hardware, when switchboard shipped in more than one section. Provide clear assembly instructions including torque setting for all bus bolts.

#### 2.5 Grounding

- .1 Copper ground bus not smaller than 50 x 6 mm extending full width of cubicle and situated at bottom.
- .2 Lugs at each end for grounding cable, suitable for 4/0 AWG cables.
- .3 Bond non-current carrying metal parts, including switchgear framework, enclosure and bases to ground bus.

#### 2.6 Circuit Breakers

- .1 Main breaker.
  - .1 Moulded case circuit breaker to operate by means of a solid

state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload conditions, and long time, short time, instantaneous tripping for ground fault short circuit protection.

- .2 Secondary breaker units as per Section 26 28 16.02.
- .3 Main breaker to have provisions for padlocking in the "OFF" position, and be clearly labeled to indicate ON and OFF positions.

## 2.7 Finishes

- .1 Apply finishes in accordance with Section 26 05 00.
  - .1 Cubicle exteriors: gray
  - .2 Cubicle interiors: white preferred.
  - .3 Supply spray cans touch-up paint, 1 for each colour.

## 2.8 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 00.
- .2 Nameplates:
  - .1 White plate, black letters, size 7.
  - .2 Complete switchboard - labeled "600V".
  - .3 Main cubicle - labeled "Main Breaker".
  - .4 Distribution Units - labeled, "Feeder No.1", "Feeder No.2", etc. Confirm wording with Consultant at time of shop drawing review.

## 2.9 Manufacturers

- .1 Acceptable Manufacturers:
  - .1 Federal Pioneer Ltd / Square D / Schneider Group
  - .2 Siemens
  - .3 Cutler Hammer/Eaton
  - .4 Commercial Switchgear
  - .5 Alternate materials as approved by addendum in accordance with General Instructions.

## PART 3 - EXECUTION

### 3.1 Installation

- .1 Locate switchboard assembly as indicated and bolt to floor. Co-ordinate final layouts within room to suit actual equipment

dimensions and Supply Authority requirements, submit to Consultant for review prior to rough-in.

- .2 Connect main secondary supply to main breaker.
- .3 Provide cabinet for Supply Authority meter, sized and located to suit Supply Authority requirements, and co-ordinate installation of meter.
- .4 Connect load side of breakers in distribution cubicles to distribution feeders as indicated.
- .5 Check factory made connections for mechanical security and electrical continuity.
- .6 Run one grounding conductor minimum #3/0 AWG bare copper from ground bus in switchboard to main ground bus in electrical room.

END OF SECTION



## PART 1 - GENERAL

### 1.1 General Requirements

- .1 Conform with requirements of front end Sections 00 and 01 as they apply to the work of this discipline.

### 1.2 Shop Drawings

- .1 Submit product data in accordance with Section 26 05 00.
- .2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

### 1.3 Plant Assembly

- .1 Install circuit breakers in panelboards before shipment.
- .2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.

## PART 2 - PRODUCTS

### 2.1 Panelboards

- .1 Panelboards: to CSA C22.2No.29.
- .2 Panelboards to be product of one manufacturer.
- .3 Bus and breakers rated for following symmetrical interrupting capacity unless otherwise indicated.  
- 120/208V Panelboards - 30 KA  
Alternatively, fault current protection may be provided by use of integrated system series rating.
- .4 Above values of interrupting capacities may be reduced if short circuit study is performed prior to shop drawing submission. Submit short circuit study results to Consultant for review with shop drawings.
- .5 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.

- .6 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .7 Two keys for each panelboard and key panelboards alike.
- .8 Copper bus with tin plated joints, to extend full height of enclosure such that each space is ready to accommodate future breaker whether indicated elsewhere in the contract documents or not.
- .9 All panelboards to be equipped with full size neutrals.
- .10 Mains suitable for bolt-on breakers.
- .11 CSA Type 1 Enclosure, finish trim and door baked grey enamel unless otherwise noted.

## 2.2 Breakers

- .1 Breakers to Section 26 28 16.02.
- .2 Breakers with thermal magnetic tripping in panel boards except as indicated otherwise
- .3 Lock-on devices for fire alarm, emergency lighting circuits, exit signage and night light circuits.

## 2.3 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 00.
- .2 Nameplate for each panelboard size 4 engraved as indicated.
- .3 Nameplate for each circuit in distribution panelboards size 2 engraved as indicated.
- .4 Complete a dated circuit directory with typewritten legend showing location and load of each circuit.

## 2.4 Acceptable Materials

- .1 Schneider
- .2 Siemens



- .3 Square D
- .4 Eaton
- .5 Alternate materials as approved by addendum in accordance with General Instructions.

### PART 3 - EXECUTION

#### 3.1 Installation

- .1 Co-ordinate with mechanical contractor to confirm final circuit breaker requirements of mechanical equipment prior to ordering distribution equipment. Bring any discrepancies to attention of Consultant.
- .2 Locate panelboards as indicated and mount securely, plumb true and square, to adjoining surfaces.
- .3 In combustible construction, provide 1 layer of 16 mm (5/8") gypsum board behind each surface mounted panel, full size of panel.
- .4 Mount panelboards to height given in Section 26 05 00 or as indicated.
- .5 Connect loads to circuits as indicated.
- .6 Connect neutral conductors to common neutral bus with respective neutral identified.
- .7 Refer to Section 26 05 34 for installation of spare conduits.

#### 3.2 Panelboard Layouts

- .1 Follow panelboard details and schedules for layout of circuits and breaker sizes wherever possible.
- .2 Record all changes to panelboard details and schedules and submit as part of "As-built" drawing set for review at completion of the project. Insert copies in each manual.

END OF SECTION



## PART 1 - GENERAL

### 1.1 General Requirements

- .1 Conform with requirements of front end Sections 00 and 01 as they apply to the work of this discipline.

## PART 2 - PRODUCTS

### 2.1 Switches

- .1 120V switches shall be rated 20A, and single pole, double pole, three-way, four-way type as indicated.
- .2 Manually-operated general purpose ac switches as indicated and with following features:
  - .1 Terminal hole approved for No.10 AWG.
  - .2 Silver alloy contacts.
  - .3 Urea or melamine moulding for parts subject to carbon tracking.
  - .4 Suitable for back and side wiring.
  - .5 White toggle.
- .3 Toggle operated fully rated for LED, tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
- .4 Switches of one manufacturer throughout project.
- .5 Acceptable Materials: Hubbell No.1221 (120V), No. 18221 (347V) or equivalents by:
  - .1 Arrow Hart No.CSB120 (120V)
  - .2 Bryant No. CSB120 (120V), No.6901 (347V)
  - .3 Leviton No.CSB1-20 (120V)
  - .4 Pass & Seymore No. CSB20AC (120V), No. PS372010 (347V)
  - .5 Alternate materials as approved by addendum in accordance with General Instructions.

### 2.2 Receptacles

- .1 Duplex receptacles, CSA type 5-15 R, 125V, 15A, U ground, specification grade with following features:
  - .1 White urea moulded housing.
  - .2 Suitable for No.10 AWG for back and side wiring.
  - .3 Break-off links for use as split receptacles.
  - .4 Eight back wired entrances, four side wiring screws.

- .5 Double wipe contacts and rivetted grounding contacts.
- .2 Single receptacles CSA type 5-15R, 125V, 15A, U ground with following features:
  - .1 White urea moulded housing.
  - .2 Suitable for No.10 AWG for back and side wiring.
  - .3 Four back wired entrances, 2 side wiring screws.
- .3 Other receptacles with ampacity and voltage as indicated.
- .4 Receptacles of one manufacturer throughout project.
- .5 Acceptable Materials:
  - .1 Hubbell No. 5262
  - .2 Arrow Hart No.5252,
  - .3 Bryant No.5262,
  - .4 Leviton No. 5262,
  - .5 Pass & Seymore No. BR15.
  - .6 Alternate materials as approved by addendum in accordance with General Instructions.

### 2.3 Special Wiring Devices

- .1 Pilot lights as indicated, with neon type 0.04W, 125V lamp and red plastic jewel flush type.
- .2 Where noted as "GFI", receptacles to be ground fault interrupting type. Feed through ground fault circuit interrupters, Class A, trip level 4 to 6 milliamps. With Test and Reset pushbuttons.

### 2.4 Cover Plates

- .1 Cover plates for wiring devices.
- .2 Cover plates from one manufacturer throughout project.
- .3 Stainless steel, vertically brushed, 1 mm thick cover plates for wiring devices mounted in a flush-mounted outlet box.
- .4 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD boxes, or utility boxes.

- .5 Weatherproof at exterior locations or indicated by "WP" on plans. Weatherproof receptacles shall be complete with cast aluminum cover plates marked "Extra Duty" while-in-use and gaskets for devices, equal to Leviton IUM series.

### PART 3 - EXECUTION

#### 3.1 Installation

- .1 Switches:
  - .1 Install single throw switches with handle in "UP" position when switch closed.
  - .2 Install devices in gang type outlet box when more than one switch is required in one location.
  - .3 Mount devices at height specified in Section 26 05 00 or as indicated.
- .2 Receptacles:
  - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location in finished areas.
  - .2 Mount receptacles at height specified in Section 26 05 00 or as indicated.
  - .3 Install GFCI receptacles with maximum of three protected downstream receptacles for all receptacles marked "GFI".
- .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.

#### 3.2 Circuit Identification

- .1 Each receptacle, control, and light switch shall have the circuit number and the supplying panel board permanently identified at the outlet with a P-touch label installed on the cover plate of the device.

END OF SECTION



## PART 1 - GENERAL

### 1.1 General Requirements

- .1 Conform with requirements of front end Sections 00 and 01 as they apply to the work of this discipline.

## PART 2 - PRODUCTS

### 2.1 Fuses - General

- .1 Fuses: product of one manufacturer.
- .2 All fuses to have minimum 200,000 amps interrupting capacity.

### 2.2 Fuse Types

- .1 Fuses shall be CSA certified HRCI - Class J/RK1/RK5 time delay with dimensions and current limiting performance in accordance with CSA C22.2 No.106.
- .2 Fuses over 200A to be current limiting type.

### 2.3 Materials

- .1 Acceptable Materials:
  - .1 Bussmann
  - .2 Edison
  - .3 Littelfuse
  - .4 Mersen/Gould
  - .5 Noram Duralim
  - .6 Alternate material as approved by addendum in accordance with General Instructions.

## PART 3 - EXECUTION

### 3.1 Installation

- .1 Co-ordinate with mechanical contractor to confirm final fuse requirements of mechanical equipment prior to ordering distribution equipment. Bring any discrepancies to attention of Consultant.
- .2 Install fuses in mounting devices immediately before energizing circuit.
- .3 Ensure correct fuses fitted to physically matched mounting devices.

- .4 Ensure correct fuses fitted to assigned electrical circuit.
- .5 At completion of work, turn over three (3) spare fuses of each type and size used, in original shipping cartons.

END OF SECTION



## PART 1 - GENERAL

### 1.1 General Requirements

- .1 Conform with requirements of front end Sections 00 and 01 as they apply to the work of this discipline.

### 1.2 References

- .1 American National Standards Institute (ANSI) / Institute of Electrical and Electronics Engineers (IEEE)
  - .1 ANSI/IEEE C37.46-2010, Specifications for High Voltage Explosion and Current-Limiting Type Power Class Fuses and Fuse Disconnecting Switches.
- .2 Electrical and Electronic Manufacturers Association of Canada (EEMAC)
  - .1 EEMAC G1-1-1958, Indoor and Outdoor Switch and Bus Insulators.
- .3 National Electrical Manufacturers Association (NEMA)
  - .1 NEMA SG2-1993, High-Voltage Fuses.
- .4 CSA C22.2 No.193 – High Voltage Full-Load Interrupter Switches.

### 1.3 Maintenance Data

- .1 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for outdoor load break switches and fuses and include product characteristics, performance criteria, physical size, finish and limitations in maintenance manuals.

### 1.4 Shop Drawings

- .1 Shop Drawings:
  - .1 Submit Shop Drawings.
    - .1 Indicate on drawings:
      - .1 Load break mechanism.
      - .2 Switching type.
      - .3 Mounting design.
      - .4 Fuse holder mechanism.
      - .5 Gang operating mechanism.
      - .6 Load rating.

### 1.5 Maintenance

Materials .1 Include: 3 spare fuses.

## PART 2 – PRODUCTS

2.1 Materials .1 Fuses: to NEMA SG2 and ANSI C37.46.

.2 Insulators: to EEMAC G1-1.

### 2.2 Full Load Air Break Switches

.1 Vertical mounted, double break, gang operated, single throw, 3 pole.

.2 Rating 200 A, 46 kV.

.1 BIL: 250 kV.

.3 Insulators: three per pole.

.4 Contacts:

.1 Silver switch blade contacts.

.5 Interrupter unit to permit opening and closing under rated full load currents consists of:

.1 Mechanism actuated by levers for operating contacts.

.2 Bolted to fixed contact assembly of switch.

.3 Shunt contact bolted to switch blade actuates interrupter unit when blade is moved to open or closed position.

.6 Switch base: 5 mm formed channel galvanized steel drilled for universal mounting on concrete pole.

.7 Interphase mechanism assembly.

.1 Poles interconnected by articulated pipe assembly to allow for minor misalignment.

.8 Manual operating mechanism with:

.1 Offset bearings.

.2 Pipe shaft.

.3 Pipe guides.

.4 Pipe couplings.

.5 Position indicator.

.6 Foot bearing.

.7 Operated with conventional hookstick.

2.3 Primary Fuses

- .1 Disconnect vertical opening type.
- .2 Voltage rating: 46 kV.
- .3 Continuous current rating: 20 A.
- .4 Three phase symmetrical short circuit ratings:
  - .1 13100 A at 46 kV.

2.4 Lightning Arrestors

- .1 Pole mounted complete with arrestor mount bracket, with following features:
  - .1 Clamp type line and ground terminals suitable for use with copper or aluminum conductor.
  - .2 Pressure relief 40 kA RMS.
  - .3 Maximum continuous line to ground operating voltage rating 39 kV MCOV.
  - .4 Duty cycle voltage rating 48 kV RMS

2.5 Acceptable Materials

- .1 Switches: S&C Alduti-Rupter series with Power Fuses.
- .2 Fuses: S&C SMD series.
- .3 Lightning arrestors: Hubbell PVI-LP
- .4 Alternate materials as approved by addendum in accordance with General Instructions.

PART 3 - EXECUTION

3.1 Installation

- .1 Install in accordance with manufacturer's instructions.
- .2 Connect switch terminals to primary conductors.
- .3 Locate, mount and connect fuses and lightning arrestors.

3.2 Field Quality Control

- .1 Perform tests in accordance with manufacturer's recommendations.

- .2 Energize and load feeders controlled by load break switches.
- .3 Open and close load break switches at least ten times to ensure proper mechanical and electrical performance of installation.
- .4 Check fuse and switch contact resistance with low resistance meter.
  - .1 Do not use more than rated current on fuse.
- .5 Megger switch across each pole, from pole to pole, and from pole to ground.

END OF SECTION

## PART 1 - GENERAL

### 1.1 General Requirements

- .1 Conform with requirements of front end Sections 00 and 01 as they apply to the work of this discipline.

### 1.2 Product Data

- .1 Submit product data, including time-current characteristic curves, for breakers with ampacity of 400A and over.

## PART 2 - PRODUCTS

### 2.1 Breakers General

- .1 Full size bolt-on moulded case circuit breaker, quick-make quick-break type, for manual and automatic operation. Half size or miniature size not acceptable.
- .2 Common-trip breakers with single handle for multiple applications.
- .3 Magnetic instantaneous trip elements in circuit breakers, to operate only when the value of current reaches setting. Trip settings on breakers with adjustable trips to range from 3-10 times current rating.
- .4 Circuit breakers with interchangeable trips on main service entrance breaker, and as indicated.
- .5 Main breaker to be service entrance rated, unless noted.
- .6 All breakers 1000A and over to have integral ground fault protection sensor, relay and self powered trip unit unless noted. Same on breakers noted with "LSIG".

- .7 New breakers in existing panels to be of same manufacturer as panel.

## 2.2 Thermal Magnetic Breakers

- .1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping under overload conditions and instantaneous magnetic tripping for short circuit protection.
- .2 Circuit breakers feeding fire pump circuits shall not be thermal overload type.

## 2.4 Optional Features

- .1 Incorporate optional features as follows and as indicated:
  - .1 On-off locking device on main service entrance breaker.

## 2.5 Acceptable Materials

- .1 Schneider
- .2 Siemens Electric Ltd.
- .3 Square D Company
- .4 Eaton
- .5 General Electric
- .6 Alternate materials as approved by addendum in accordance with General Instructions.

## PART 3 - EXECUTION

### 3.1 Installation

- .1 Co-ordinate with mechanical contractor to confirm final circuit breaker requirements of mechanical equipment prior to ordering distribution equipment. Bring any discrepancies to attention of Consultant.
- .2 Install circuit breakers as indicated.

END OF SECTION





## PART 1 - GENERAL

### 1.1 General Requirements

- .1 Conform with requirements of front end Sections 00 and 01 as they apply to the work of this discipline.

### 1.2 Shop Drawings and Product Data

- .1 Submit product data in accordance with Section 26 05 00.
- .2 Ground fault protective equipment to be product of one manufacturer.

## PART 2 - PRODUCTS

### 2.1 Equipment

- .1 Provide ground fault protection on the main service breaker.
- .2 Ground fault unit to contain:
  - .1 Ground sensing relay suitable for relay operation, factory set. Control voltage 120V.
  - .2 Three position switch to select value at which relay will operate.
  - .3 Three position switch to select time delay on operation.

## PART 3 - EXECUTION

### 3.1 Testing

- .1 Arrange and pay for field testing of ground fault equipment by ground fault equipment manufacturer before commissioning service.
- .2 Submit report of tests to Consultant and a certificate that system as installed meets criteria specified herein.
- .3 Demonstrate simulated ground fault tests.

END OF SECTION



## PART 1 - GENERAL

### 1.1 General Requirements

- .1 Conform with requirements of front end Sections 00 and 01 as they apply to the work of this discipline.
- .2 Conform with requirements of:
  - .1 CSA Z462 Workplace Electrical Safety;
  - .2 ANSI Z535.4 Product Safety Signs and Labels;
  - .3 IEEE 1584 Guide for Performing Arc-Flash Hazard Calculations.

### 1.2 Submittals

- .1 The coordination and arc flash studies shall be submitted in order to make adjustments to equipment (if required) before equipment is released for manufacturing. Before the final commissioning date, submit six (6) copies of the study. The study shall include the following sections:
  - .1 Description, basis and scope of the study together with a single line diagram of the power system which is included within the study.
  - .2 Protective device time versus current co-ordination curves, tabulations of relay and circuit breaker trip settings, fuse selection and commentary regarding same.
  - .3 Fault current calculations.
  - .4 Arc flash calculations and warning signs.

### 1.3 Scope of Work

- .1 The objective of the study is to obtain optimum protection and co-ordination performance of the power system devices, and to determine the incident energy potential and arc flash boundary of each piece of electrical distribution equipment in the facility.
- .2 The study shall include all portions of the electrical distribution system from the normal and alternate sources of power throughout the 8.32 KV distribution system and the low voltage distribution system up to the highest rated device in each distribution panelboard.
- .3 The study shall include the necessary calculations and logic decisions required to select or to verify the selection of power fuse ratings, protective relay characteristics and settings, ratios and

characteristics of associated current transformers, low voltage breaker trip characteristics and settings.

- .4 The co-ordination study shall include all voltage classes of equipment including the utility incoming line protective device. The phase and ground over current protection shall be included as well as settings for all adjustable over current and voltage sensing protective devices.
- .5 The time current characteristics plots of the specified protective devices shall include complete titles, representative one line diagram and legends, associated relays or fuse characteristics, significant motor starting characteristics, complete parameters of transformers including inrush current, complete operating bands of low voltage circuit breaker trip curves and fuse curves.
- .6 Show the inrush current of transformers along with the curves of the associated overcurrent protection devices. Where multiple transformers are fed downstream of a common overcurrent protection device, plot the combined inrush current of the group of transformers along with the curve of the common overcurrent protection device. Identify any co-ordination issues.
- .7 Reasonable co-ordination intervals and separation of characteristics curves shall be maintained.
- .8 The co-ordination plots for phase and ground protective devices shall be provided on a system basis. Separate curves shall be used to clearly indicate the co-ordination achieved for each utility main breaker, primary feeder breaker, main secondary breakers, substation feeder breakers and main load protective device rated 150A or more. There shall be a maximum of six (6) protective devices per plot.
- .9 The selection and settings of the protective devices shall be provided separately in a tabulated form listing circuit identification, C/T ratios, manufacturer, type, range of adjustment and recommended settings.
- .10 Perform an Arc Flash Analysis study by a qualified technical representative for all new and existing electrical equipment included in the project as per the standards referenced in this Section and

provide labeling of all electrical equipment. Labeling types shall be as described by these standards

1.4 Acceptable  
Supplier

- .1 The studies shall be prepared by an independent certified testing company complete with certificate stamped and signed by a Professional Engineer licensed to practice in Ontario.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

3.1 Adjustments

- .1 Make the adjustments of the protective devices as recommended in the study.

3.2 Testing of  
Devices

- .1 After the protective devices have been adjusted to the recommended settings, perform tests to ascertain proper operation.
- .2 Submit letter indicating recommended settings have been made and tested. Letter shall be authored, signed, and sealed by the same Professional Engineer who prepared the study.

3.3 Arc Flash  
Labeling

- .1 Apply labels on distribution equipment indicating available arc flash values and supplementary information per the referenced standards.

END OF SECTION



## PART 1 - GENERAL

1.1 General Requirements .1 Conform with requirements of front end Sections 00 and 01 as they apply to the work of this discipline.

1.2 Product Data .1 Submit product data in accordance with Section 26 05 00.

## PART 2 - PRODUCTS

2.1 Equipment .1 Enclosed manual air break switches in non-hazardous locations: to CSA C22.2 No.4.

.2 Fuse holder assemblies to CSA C22.2 No.39.

.3 Fusible and non-fusible disconnect switch in CSA Type 2 Enclosure as indicated.

.4 Provision for padlocking in On-Off switch position by locks.

.5 Mechanically interlocked door to prevent opening when handle in ON position.

.6 Fuses as indicated in accordance with Section 26 28 13.01.

.7 Fuse holders in each switch suitable without adaptors, for type of fuse as indicated.

.8 Quick-make, quick-break action.

.9 ON-OFF switch position indication on switch enclosure cover.

2.2 Equipment Identification .1 Indicate name of load controlled on size 4 nameplate to Section 26 05 00.

2.3 Acceptable  
Materials

- .1 Siemens
- .2 Square D / Schneider
- .3 Eaton
- .4 General Electric
- .5 Alternate materials as approved by addendum in accordance with General Instructions.

PART 3 - EXECUTION

3.1 Installation

- .1 Co-ordinate with mechanical contractor to confirm final fuse requirements of mechanical equipment prior to ordering distribution equipment. Bring any discrepancies to attention of Consultant.
- .2 Install disconnect switches complete with fuses as indicated.
- .3 Main disconnect switches are shown. Provide additional disconnect switches as required to satisfy Inspection Authority and to satisfy Code requirements.

END OF SECTION



## PART 1 - GENERAL

### 1.1 General Requirements

- .1 Conform with requirements of front end Sections 00 and 01 as they apply to the work of this discipline.

### 1.2 Product Data

- .1 Submit product data per Section 26 05 00 for Contactors over 100A.

## PART 2 - PRODUCTS

### 2.1 Contactors

- .1 Contactors: to CSA C22.2No.14 and EEMAC No.1CS.
- .2 Electrically held controlled by pilot devices as indicated and rated for type of load controlled. Half size contactors not accepted.
- .3 Breaker or fused switch combination contactor as indicated.
- .4 Complete with 1 normally open and 1 normally closed auxiliary contacts for Owner's use unless indicated otherwise.
- .5 Mount in CSA Type 1 enclosure unless otherwise indicated.
- .6 Include following options in cover unless otherwise noted.
  - .1 Red indicating lamp when contactor "ON".
  - .2 Hand-off-auto selector switch with terminals for external connections.
- .7 Control transformer and secondary fuse in contactor enclosure for 120V control.

### 2.2 Equipment Identification

- .1 Size 4 nameplate in accordance with Section 26 05 00 indicating name of load controlled.

2.3 Acceptable  
Materials

- .1 Allen-Bradley
- .2 General Electric
- .3 Eaton
- .4 Square D
- .5 Siemens
- .6 ASCO
- .7 Alternate materials as approved by addendum in accordance with General Instructions.

PART 3 - EXECUTION

3.1 Installation

- .1 Install contactors and connect auxiliary control devices as indicated.

END OF SECTION

## PART 1 - GENERAL

### 1.1 General Requirements

- .1 Conform with requirements of front end Sections 00 and 01 as they apply to the work of this discipline.

### 1.2 Shop Drawings and Product Data

- .1 Submit shop drawings and product data in accordance with Section 26 05 00.
- .2 Indicate:
  - .1 Mounting method and dimensions.
  - .2 Starter 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.

### 1.3 Operation and Maintenance Data

- .1 Provide data for incorporation into maintenance manual specified in Section 26 05 00.
- .2 Include operation and maintenance data for each type and style of starter.

## PART 2 - PRODUCTS

### 2.1 Materials

- .1 Starters to be product of one manufacturer.
- .2 Starters: to CSA C22.2 No.14, EEMAC E14-1. Half size starters not acceptable.
- .3 CSA Type 1 enclosures.

### 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 Overload heater in each phase leg, manual reset, with trip indicating handle.

.2 Accessories:

- .1 Toggle switch: standard labelled as indicated.
- .2 Indicating light: standard type and colour as indicated.
- .3 Locking tab to permit padlocking in 'ON' or 'OFF' position.

2.3 Full Voltage  
Magnetic  
Starters

- .1 Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
  - .1 Contactor solenoid operated, rapid action type.
  - .2 Motor overload protective device in each phase, manually reset from outside enclosure.
  - .3 Power and control terminals.
  - .4 Thermistor interface where required, co-ordinate with mechanical contractor.
  - .5 Wiring and schematic diagram inside starter enclosure in visible location.
  - .6 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
- .2 Combination type starter to include 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 Locking in 'ON' position.
  - .3 Independent locking of enclosure door.
  - .4 Provisions for preventing switching to 'ON' position while enclosure door open.
- .3 Accessories:
  - .1 Pushbuttons and selector switches: "Test-Off-Auto" with spring return from Test, unless otherwise noted.
  - .2 Indicating lights: push-to-test type and colour 1 green 'ON' unless otherwise noted.
  - .3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.

2.4 Control  
Transformer

- .1 Single phase, dry type, control transformer with primary voltage to suit motor voltage and 120V secondary, complete with secondary fuse, installed in starter.
- .2 Size control transformer for control circuit load plus 20% spare capacity. Co-ordinate with mechanical contractor to determine circuit requirements.

2.5 Finishes

- .1 Apply finishes to enclosure in accordance with Section 26 05 00.

2.6 Equipment  
Identification

- .1 Provide equipment identification in accordance with Section 26 05 00.
- .2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.
- .3 Magnetic starter designation label, white plate, black letters, size 5 engraved as indicated.

2.7 Acceptable  
Materials

- .1 Allen Bradley
- .2 Eaton
- .3 General Electric
- .4 Moeller
- .5 Schneider
- .6 Siemens
- .7 Square D
- .8 Alternate material as approved by addendum in accordance with General Instructions.

### PART 3 - EXECUTION

#### 3.1 Installation

- .1 Co-ordinate with mechanical contractor to confirm final starter requirements of mechanical equipment prior to ordering starter or distribution equipment. Bring any discrepancies to attention of Consultant.
- .2 Install starters, connect power and control as indicated.
- .3 Ensure correct fuses and overload devices elements installed.

#### 3.2 Tests

- .1 Perform tests in accordance with Section 26 05 00 and manufacturer's instructions.
- .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 Before starting the motors:
  - .1 Make sure that the section supplying the motor is present.
  - .2 Check the rotation with the concerned section.

#### 3.3 Report

- .1 Upon completion of the wiring of all motors, present to the Consultant a typewritten report of voltage and phase currents at the motor terminals together with the motor HP rating, nameplate full load amps, overload setting and identification of the motor.

END OF SECTION

## PART 1 - GENERAL

### 1.1 General Requirements

- .1 Conform with requirements of front end Sections 00 and 01 as they apply to the work of this discipline.
- .2 Conform to requirements of ANSI/UL 1449 latest edition and ANSI/IEEE C62.41.

### 1.2 Summary

- .1 This Section describes the materials and installation requirements for surge protective devices (SPDs), installed at panelboards for the protection of all AC electrical circuits from the effects of lightning induced currents, substation switching transients and internally generated transients resulting from inductive and/or capacitive load switching.

### 1.3 Shop Drawings

- .1 Submit product data in accordance with Section 26 05 00.
- .2 Provide verification that the SPD complies with the required ANSI/UL 1449 listing by Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL). Include the following information at a minimum: model number, SPD Type, system voltage, phases, modes of protection, Voltage Protection Rating (VPR), and Nominal Discharge Current (In).

## PART 2 - PRODUCTS

### 2.1 Surge Protection

- .1 SPDs shall comply with ANSI/UL 1449.
- .2 SPDs shall provide suppression elements between each phase conductor and the system neutral and between the neutral conductor and ground.
- .3 Visible indication of proper SPD connection and operation shall be provided. The indicator lights shall indicate which phase as well as which module is fully operable.
- .4 The mounting position of the SPD shall permit a short lead length between the suppressor and the point of connection.

- .5 The SPD shall be equipped with an audible alarm which shall actuate when any one of the surge current modules has failed. An alarm ON/OFF switch shall be provided to silence the alarm and an alarm push-to-test switch shall be provided to test the alarm.
- .6 SPD shall be complete with dry contacts for connection to remote monitoring system to indicate failure of the unit on any Phase.
- .7 The suppressor will have a warranty guarantee for a period of five years.
- .8 Unit Operating Voltage – 120/208V.
- .9 The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels.
- .10 Protection Modes – The SPD must protect all modes of the electrical system being utilized: L-N, L-G, L-L and N-G.
- .11 Maintenance Free Design – The SPD shall be maintenance free and shall not require any user intervention for service or testing throughout its life. SPDs shall not contain replaceable items such as modules, fuses, or batteries
- .12 Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Design shall not incorporate replaceable SPD modules.
- .13 Monitoring Diagnostics – Each SPD shall provide the following integral monitoring options:
  - .1 Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase. For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode.
  - .2 Remote Status Monitor – The SPD shall include Form C dry contacts (one NO and one NC) for remote annunciation of its



- status. Both the NO and NC contacts shall change state under any fault condition.
- .3 Audible Alarm and Silence Button – The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.
- .4 Surge Counter (for category C units per table below) – The SPD shall be equipped with a display that indicates to the user how many surges have occurred at the location. A reset pushbutton shall be standard, allowing the surge counter to be zeroed. The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.
- .14 The SPD applications covered under this section include distribution and branch panel locations, busway, motor control centers (MCC), switchgear, and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.
- .1 Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
CATEGORY	Application (general)	Per Phase	Per Mode
C	Service Entrance Locations, Switchboards	240 kA	120 kA
B	Distribution Panelboards	160 kA	80 kA
A	Branch Panelboards	120 kA	60 kA

- .15 Nominal Discharge Current of 20 kA.
- .16 Maximum Continuous Operating Voltage (MCOV) – The MCOV shall not be less than 125% of the nominal system operating voltage.

- .17 Voltage Protection Rating (VPR) – The maximum VPR for the device shall not exceed the following:

Modes	208Y/120
L-N; L-G; N-G	700
L-L	1200

- .18 Electrical Noise Filter – Each unit shall include an EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method.
- .19 The SPD shall be protected by an overcurrent protective device within the source it is connected to, sized to manufacturer's recommendations, minimum 30 amps.
- .20 SPD enclosure shall be CSA Type 1.

## 2.2 Acceptable Materials

- .1 Manufacturers: Subject to compliance with these specifications, provide products from Eaton SPD Max Series or equivalent from one of the following:
- .1 Current Technologies
  - .2 Emerson / Liebert
  - .3 General Electric
  - .4 LEA International
  - .5 Square D Surge Logic
  - .6 Siemens
  - .7 Total Protection Solutions
  - .8 Innosys Power

## PART 3 - EXECUTION

### 3.1 Surge Suppression

- .1 Install as indicated and to manufacturer's recommendations.
- .2 The SPD shall be located directly adjacent to its overcurrent protective device with a minimum wiring lead length. Keep leads as short as possible to ensure optimum performance. Any excess

conductor length shall be trimmed in order to minimize let-through voltage.

END OF SECTION



## PART 1 - GENERAL

- 1.1 General Requirements .1 Conform with requirements of front end Sections 00 and 01 as they apply to the work of this discipline.
- 1.2 Related Work .1 Sprinkler Systems: Section 21 13 10
- 1.3 General .1 Contractors are to verify with Owner before making any connection to any existing systems. This will ensure that (1) the Owner is aware that work will be done on a system and (2) that the contractor is working on a system that is working when he starts his work. If anomalies are not reported, it will be assumed that the system was fully functional.
- .2 The operation of the system shall remain the same. The additional devices shall operate as per existing devices.
- 1.4 Description of Systems .1 The existing control is manufactured by Edwards EST. The system is also equipped with remote annunciators.
- 1.5 Shop Drawings .1 Submit shop drawings in accordance with Section 26 05 00.
- 1.6 New Equipment .1 Provide new devices where necessary to complete the design as shown. All devices to be product of one manufacturer.
- .2 New equipment to match in appearance and function existing equipment.
- .3 Balance of this section applies to new equipment.

## PART 2 - PRODUCTS

- 2.1 Materials Underwriter's Laboratories of Canada (ULC), Latest Issue.
- .1 CAN/ULC-S524 Installation of Fire Alarm Systems.

- |     |              |  |
|-----|--------------|--|
| .2  | ULC-S525     | Audible Signal Appliances.                 |
| .3  | CAN/ULC-S526 | Visual Signal Appliances, Fire Alarm.      |
| .4  | CAN/ULC-S527 | Control Units.                             |
| .5  | CAN/ULC-S528 | Pull Stations.                             |
| .6  | CAN/ULC-529  | Smoke Detectors.                           |
| .7  | CAN/ULC-530  | Heat Actuated Fire Detectors.              |
| .8  | CAN/ULC-531  | Smoke Alarms                               |
| .9  | CAN/ULC-536  | Inspection & Testing of Fire Alarm Systems |
| .10 | CAN/ULC-S537 | Verification of Fire Alarm Systems         |

## 2.2 Control Panel

- |    |   |
|----|---|
| .1 | Use existing control panel.   |
| .2 | Provide any additional equipment needed to support the devices and layout shown, as required by the panel manufacturer and to meet the certification procedure for the complete system. |

## 2.3 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 as indicated. |
|----|---|

## 2.4 Auxiliary Circuits

- |    |   |
|----|---|
| .1 | Actual status indication (positive feedback) from controlled device.                                    |
| .3 | Alarm, supervisory and/or trouble on system to cause operation of programmed auxiliary output circuits. |

- .4 Upon resetting the system, auxiliary contacts to return to normal or to operate as pre-programmed.

2.5 Acceptable  
Manufacturers

- .1 Acceptable manufacturers for fire alarm systems: to match existing.

PART 3 - EXECUTION

3.1 Installation

- .1 Install systems: to CAN/ULC-S524.
- .2 Connect existing control panel as indicated.
- .3 Connect signalling circuits to main control panel. Ensure output is synchronized.
- .4 Install end-of-line devices at end of alarm and signalling circuits as needed.
- .5 Modify annunciator panels are required.

3.2 Verification

- .1 Perform verification in accordance with Section 26 05 00 and CAN/ULC -S537.
- .2 Fire alarm system: Fire alarm system:
  - .1 Verify each device and alarm circuit to ensure affected manual stations, thermal and smoke detectors, sprinkler system, transmit alarm to control panel and actuate general alarm.
  - .2 Check annunciator panels to ensure zones are shown correctly.
  - .3 Simulate grounds and breaks on alarm and signalling circuits to ensure proper operation of trouble signals.
  - .4 Perform testing of integrated fire protection and life safety systems as per CAN/ULC-S1001 as referenced in the Ontario Building Code. Electrical contractor shall be fully responsible for all work associated with these requirements. Co-ordinate with and retain other trades as required.
  - .5 Upon receipt of satisfactory verification certificate, the Consultant shall produce and submit a general review declaration letter for the municipality, provided no other deficiencies are noted in Consultant's final site review.

- .6 Following successful verification, contractor to make all arrangements for testing and demonstration of system after normal working hours in the presence of the municipal official, to the satisfaction of the property manager. Tender price to include all costs associated with such arrangements, verification and testing of system, and municipal inspection fees.
- .7 Note that the municipal official requires the Consultant's general review declaration letter prior to issuing an occupancy permit. Once deficiencies noted during the final normal hours field review have been corrected and a copy of the signed verification certificate has been received, the Consultant will issue general review declaration. The Consultant is not required to witness the after-hours system demonstration.
- .8 Notify Owner, Consultant and Fire Marshall at least 72 hours before demonstrating operation of complete system.
- .9 Obtain certificate of compliance from authorized representative of manufacturer. Forward original to Consultant and insert copies in each maintenance manual.

END OF SECTION



## PART 1 - GENERAL

### 1.1 General Requirements

- .1 Conform with requirements of front end Sections 00 and 01 as they apply to the work of this discipline.

### 1.2 Related Work

- .1 Excavation and backfilling by Electrical Contractor.

### 1.3 Shop Drawings

- .1 Submit shop drawings in accordance with Section 26 05 00 for pad mounted transformer base.

## PART 2 – PRODUCTS

### 2.1 Materials

- .1 PVC underground telecommunication cable ducting: to CSA B196.3.
- .2 Type DB2 Plastic underground power cable ducting: to CSA B196.1.

### 2.2 PVC Ducts

- .1 Rigid PVC ducts, type DB2, encased in reinforced concrete, size as indicated.

### 2.3 PVC Duct Fittings

- .1 Rigid PVC type couplings, bell end fittings, plugs, caps, adaptors as required to make complete installation.
- .2 Expansion joints where required or indicated.
- .3 Rigid PVC 5 deg. angle couplings as required for curves.
- .4 Rigid PVC long radius bends for 45 deg. and 90 deg. turns.

2.4 Concrete  
Base

- .1 Concrete base as noted on drawings and as per requirements of Inspection Authority.
- .2 Electrical contractor to verify exact base size requirements.

2.5 Cable  
Pulling  
Equipment

- .1 Stranded 6 mm polypropylene pull rope tensile strength 5 KN continuous throughout each duct run with 3 m spare rope at each end.

PART 3 - EXECUTION

3.1 Installation  
General

- .1 Provide reinforced concrete encased underground duct banks including formwork.
- .2 Provide base and foundation to Standards of Inspection Authority.
- .3 Build duct bank on undisturbed soil or on well compacted granular fill not less than 150 mm thick, compacted to 95% of maximum proctor dry density, or as required to suit geotechnical report for the specific site conditions of this project, whichever is more stringent.
- .4 Open trench completely before ducts are laid and ensure that no obstructions will necessitate change in grade of ducts.
- .5 Prior to laying ducts, construct mud slab not less than 75 mm thick.
- .6 Install ducts to obtain minimum cover shown, and minimum slope of 1 to 400 to gravel soak pit at low point. Wherever possible, locate soak pit at building perimeter drain system. Provide holes in bottom of ducts for drainage to soak pit.
- .7 Install base spacers at maximum intervals of 1500 mm for bottom layer of ducts.
- .8 Lay PVC ducts with configuration and reinforcing with preformed interlocking, rigid plastic intermediate spacers to maintain spacing between ducts. Stagger joints in adjacent layers at least 150 mm and make joints watertight. Encase duct bank with 75 mm thick concrete cover.

- .9 Make transpositions, offsets and changes in direction using 5 deg. bend sections, do not exceed a total of 20 deg. with duct offset.
- .10 Use bell ends at duct terminations in manholes or buildings.
- .11 Use conduit to duct adapters when connecting to conduits.
- .12 Terminate duct runs with a duct coupling set flush with the end of the concrete envelope when dead ending duct bank for future extension.
- .13 Cut, ream and taper end of ducts in field to manufacturer's recommendations, so that duct ends are fully equal to factory-made ends.
- .14 Allow concrete to attain 50% of its specified strength before backfilling.
- .15 Use anchors, ties and trench jacks as required to secure ducts and prevent moving during pouring of concrete. Tie ducts to spacers with twine or other non-metallic material. Remove weights or wood braces before concrete has set and fill voids.
- .16 Clean ducts before laying. Cap ends of ducts during construction and after installation to prevent entrance of foreign materials.
- .17 Immediately after pouring of concrete, pull through each duct a wooden mandrel not less than 300 mm long and of a diameter 5 mm less than internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign matter. Avoid disturbing or damaging ducts where concrete has not set completely. Pull stiff bristle brush through each duct immediately before pulling-in cables.
- .18 Install four 3 m lengths of 15 m reinforcing rods, one in each corner of duct bank when connecting duct to manholes or buildings. Wire the rods to 15 m dowels at manhole or building and support from duct spacers. Protect existing cables and equipment when breaking into existing manholes. Place concrete down sides of duct bank filling space under and around ducts. Rod concrete with flat bar between vertical rows filling voids.

### 3.2 Inspections

- .1 Advise Consultant with 48 hours notice so that he may inspect ducts prior to pouring and be present during pour of concrete and clean-out.

- .2 The duct run must be examined by Inspection Authority before concrete is poured.
- .3 The completed ducts must be rodded by the contractor in the presence of an Inspection Authority Inspector.
- .4 Backfilling material to be approved by Inspection Authority.

END OF SECTION

## PART 1 - GENERAL

- |                                 |    |   |
|---------------------------------|----|---|
| <u>1.1 General Requirements</u> | .1 | Conform with requirements of front end Sections 00 and 01 as they apply to the work of this discipline. |
| <u>1.2 Related Work</u>         | .1 | Excavation and backfilling by Electrical Contractor.  |

## PART 2 - PRODUCTS

- |                                   |    |  |
|-----------------------------------|----|--|
| <u>2.1 Materials</u>              | .1 | Plastic underground power cable ducting: to CSA B196.1.  |
|                                   | .2 | PVC underground telecommunication cable ducting: to CSA B196.3.  |
|                                   | .3 | Plastic polyethylene pipe not acceptable.  |
| <u>2.2 PVC Ducts</u>              | .1 | Rigid PVC ducts for direct burial, size as indicated with minimum wall thickness at any point of 2.8 mm, Type II duct. |
|                                   | .2 | Rigid PVC couplings, reducers, bell end fittings, plugs, caps, adaptors as required to make complete installation.     |
|                                   | .3 | Rigid PVC 90 and 45 bends as required.   |
|                                   | .4 | Rigid PVC 5 angle couplings as required.   |
|                                   | .5 | Expansion joints as required.  |
|                                   | .6 | Rigid PVC split ducts as indicated.  |
| <u>2.3 Solvent Weld Couplings</u> | .1 | Solvent weld compound for PVC duct joints.   |

2.4 Cable  
Pulling  
Equipment

- .1 6 mm stranded nylon pull rope tensile strength 5 kN.

PART 3 - EXECUTION

3.1 Installation

- .1 Install ducts as indicated and to manufacturer's instructions.
- .2 Clean inside of ducts before laying.
- .3 Ensure full, even support every 1.5 m throughout duct length.
- .4 Slope ducts as indicated with 1 to 400 minimum slope, and install drain pit at low point, or drain to building perimeter drain.
- .5 During construction, cap ends of ducts to prevent entrance of foreign materials.
- .6 Pull through each duct a wooden mandrel not less than 300 mm long and of a diameter 6 mm less than internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign matter. Pull stiff bristle brush through each duct immediately before pulling-in cables.
- .7 In each duct install pull rope continuous throughout each duct run with 3 m spare rope at each end. Seal ends of duct immediately after installation of pull rope.

END OF SECTION

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PART 1 - GENERAL

1.1 General  
Requirements

- .1 Conform with requirements of front end Sections 00 and 01 as they apply to the work of this discipline.

PART 2 - PRODUCTS

2.1 Materials

- .1 Spun concrete Utility poles : to CSA A14-M2000 and CAN3-A23.3M1984.
- .2 Power line hardware: to CAN/CSA-C83-M87.

2.2 Poles

- .1 Spun concrete reinforced type.
- .2 Classification type L unless otherwise indicated on drawings.
- .3 New poles.
- .4 Length: 16.8 meters unless otherwise indicated on drawings.
- .5 Suitable for direct burial, with concrete base.
- .6 Hollow raceway for internal wires.
- .7 Prefabricated holes, inserts and couplings.
- .8 Light grey colour.

2.3 Insulators

- .1 Primary three wire service racks as required.

2.4 Crossarms

- .1 To suit primary dead end and load break switches.

---

PART 3 - EXECUTION

3.1 Preparation  
of Poles

- .1 Install crossarms and braces.
- .2 Attach stand-off insulators and eye-bolts.
- .3 Install primary racks and load break switches.

3.2 Installation

- .1 Locate and dig pole holes. Make holes large enough to allow space for tamping backfill.
- .2 Set poles.
- .3 Set poles to maintain even grade. Allow for contour of terrain and do not exceed grading of 1.5 m per pole.
- .4 Pour concrete footing around pole base. Submit Engineered base shop drawing stamped and signed by Professional Engineer licensed in Ontario.
- .5 Replace backfill in 150 mm layers. Tamp each layer and apply final layer to drain water away from pole.
- .6 Install insulators.
- .7 Identify primary circuit on pole showing phasing of each conductor, every 1000 m and including origin of primary pole.

END OF SECTION



# Appendix A

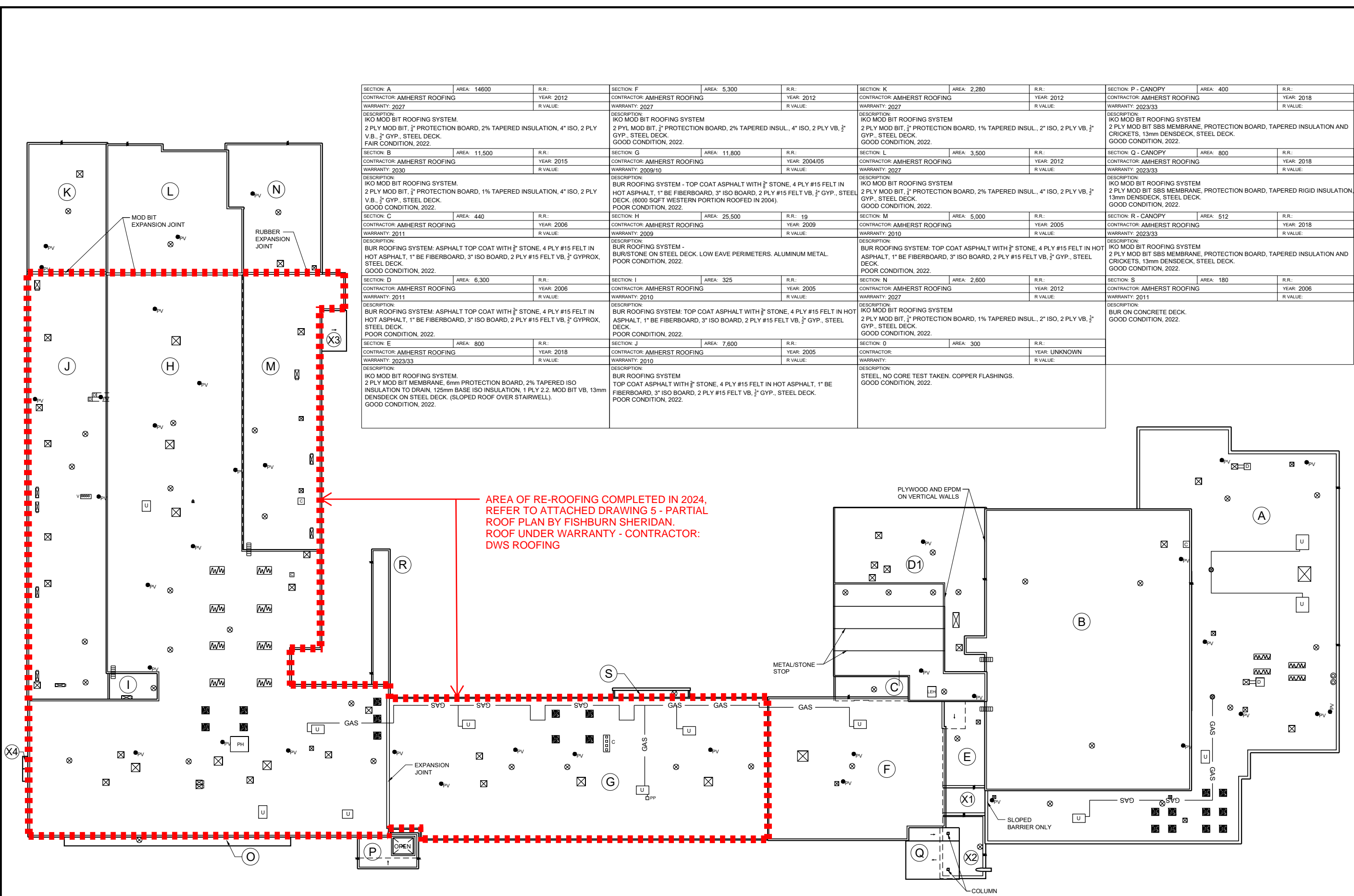
The enclosed Hazardous Building Materials Assessment is part of this scope of work, prepared by the Owner's separate consultant. During construction, notify the Owner Representative immediately for clarification if the contractor has any questions regarding the presence of hazardous materials.



# Appendix B

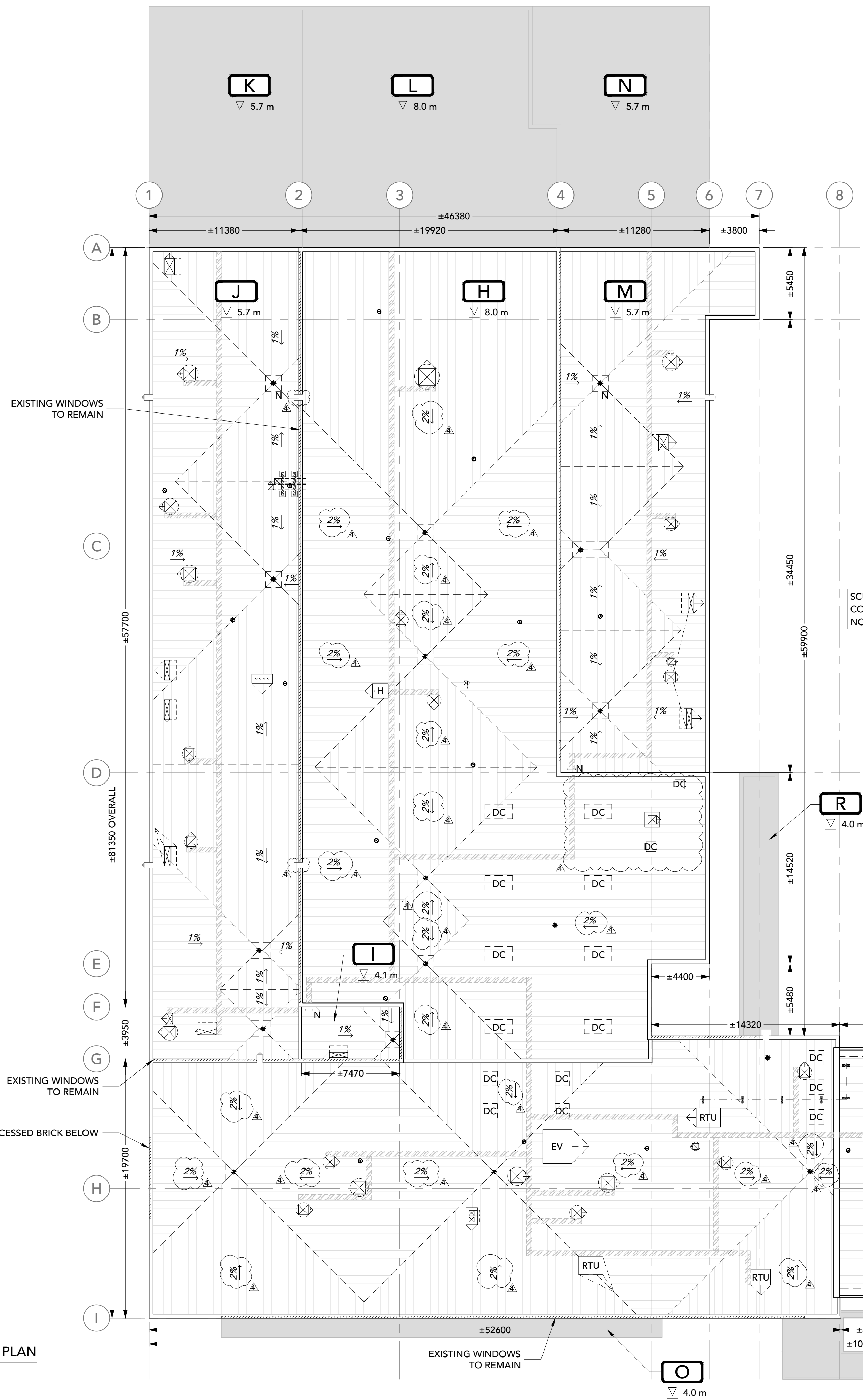
Roof Plans:  
Existing Roofing Systems, Contractor and Warranty Information





SYMBOL LEGEND		
●	PLUMBING VENT	
⊗	ROOF DRAIN	
⊗	FAN EXHAUST	
⊗	GOOSE NECK FAN EXHAUST	
U	HVAC UNITS	
⊙	CHIMNEY STACK	
⊗	GAS LINE OUTLET	
■	SCUPPER	
C	CHIMNEY CURB	
D	DUCT	
	LADDER	
—	GAS LINE	
W	SKYLIGHT	
V	VENT CURB	

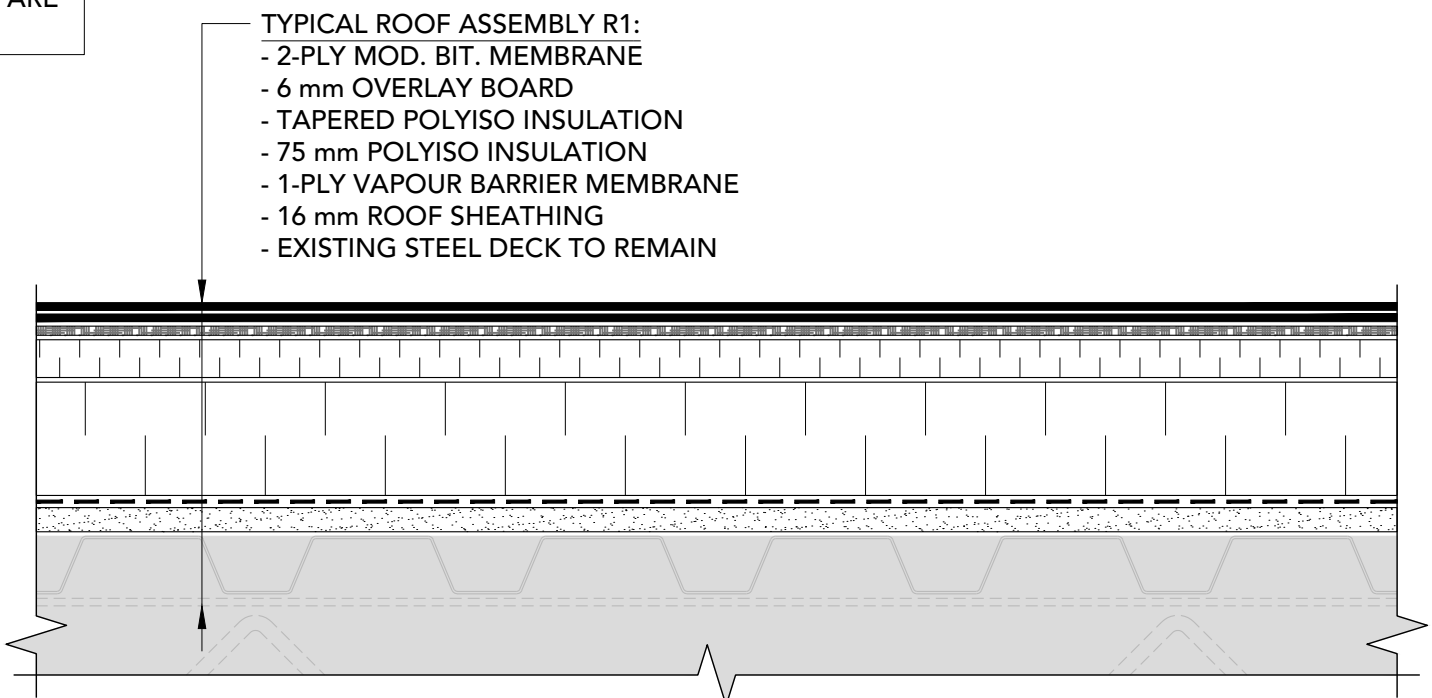
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DATE	No.	REVISION
designed by	XX	north arrow
drawn by		
checked by		
scale		
date	DECEMBER 2022	
OWNER UPPER CANADA DISTRICT SCHOOL BOARD		
PROJECT THOUSAND ISLANDS SECONDARY SCHOOL 2510 PARKDALE AVE BROCKVILLE ONTARIO		
TITLE ROOF PLAN		
1		



PARTIAL ROOF PLAN  
1:200

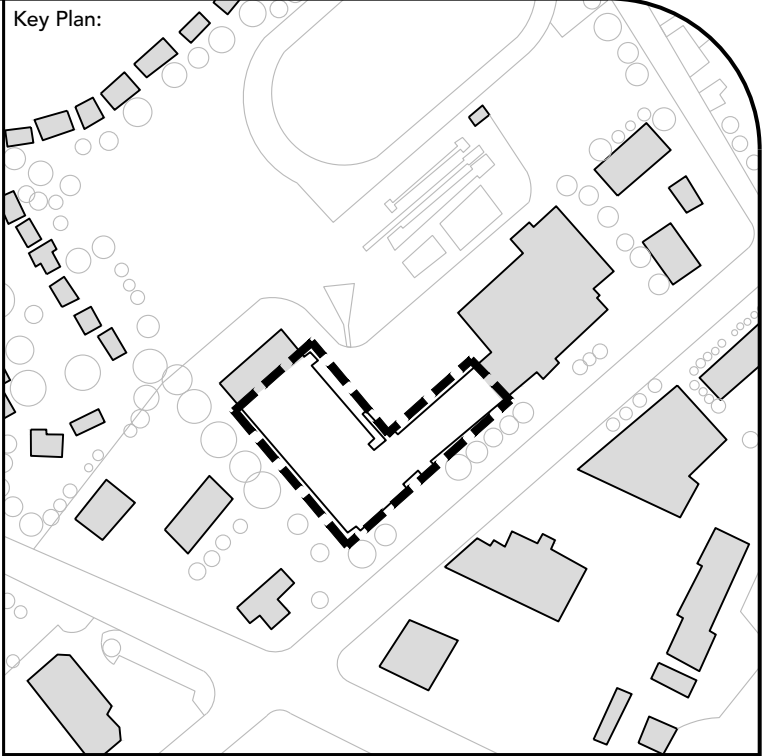
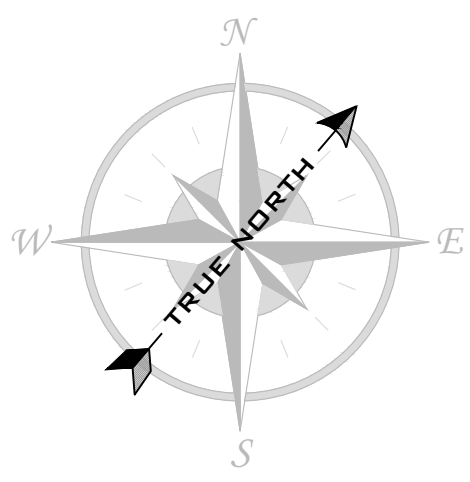
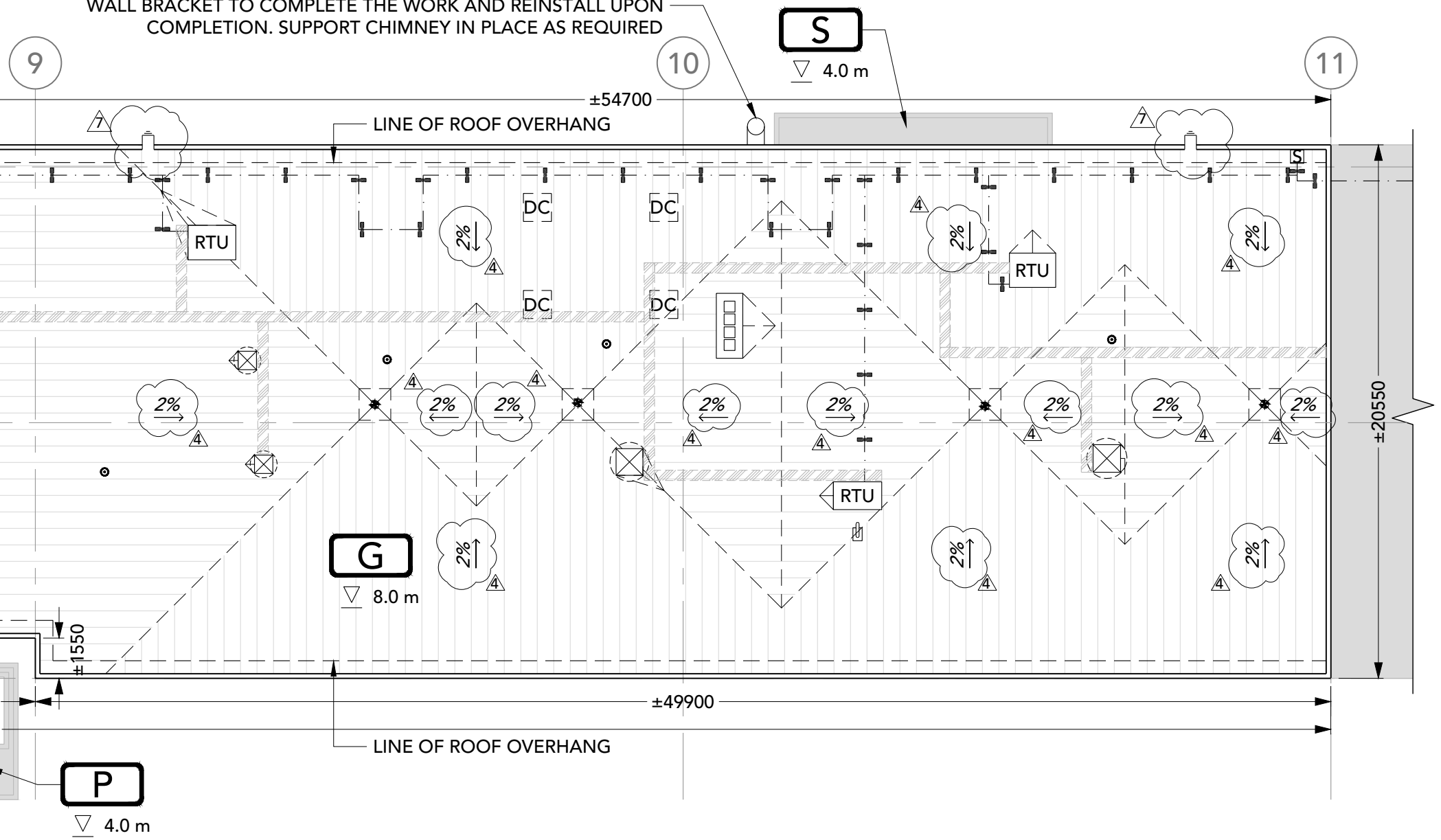
LEGEND			
SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	ROOF NUMBER AND ELEVATION		EXISTING PLUMBING VENT TO REMAIN. SEE DETAIL 16/11.
	EXISTING ROOF AREAS TO REMAIN		SUPPLY AND INSTALL ROOF DRAIN COMPLETE WITH TAPERED INSULATION SUMP, IN EXISTING LOCATION. REFER TO MECHANICAL AND DETAIL 14/11.
	SUPPLY AND INSTALL EXHAUST FAN AND INSULATED, PREMANUFACTURED STEEL CURB. REFER TO MECHANICAL AND DETAIL 17/11.		SUPPLY AND INSTALL ROOF DRAIN COMPLETE WITH TAPERED INSULATION SUMP, IN NEW LOCATION. REFER TO MECHANICAL AND DETAIL 15/11.
	SUPPLY AND INSTALL CURBED VENT AND INSULATED, PREMANUFACTURED STEEL CURB. REFER TO MECHANICAL AND DETAIL 18/12.		EXISTING ROOF HATCH TO REMAIN. SEE DETAIL 30/14.
	EXISTING ELEVATOR SHAFT CURB TO REMAIN. SEE DETAIL 23/12.		SUPPLY AND INSTALL ROOF ACCESS LADDER. REFER TO ARCHITECTURAL AND DETAIL 29/14.
	SUPPLY AND INSTALL GAS SERVICE AND SUSPENDED GAS LINE SUPPORTS. REFER TO MECHANICAL AND DETAIL 27/13.		SUPPLY AND INSTALL ROOFTOP UNIT AND INSULATED, PREMANUFACTURED STEEL CURB. REFER TO MECHANICAL AND DETAIL 25/13.
	SUPPLY AND INSTALL GOOSENECK DUCT AND INSULATED PREMANUFACTURED STEEL CURB. REFER TO MECHANICAL AND DETAIL 19/12.		DECK CLOSURE TO BE INSTALLED. SEE DETAIL 28/13.
	SUPPLY AND INSTALL CURBED GOOSENECK DUCT AND INSULATED PREMANUFACTURED STEEL CURB. REFER TO MECHANICAL AND DETAIL 19/12.		EXISTING CURBED VENT STACKS. REFER TO MECHANICAL AND DETAIL 20/12.
	SUPPLY AND INSTALL PREMANUFACTURED CABLE FLASHING. REFER TO MECHANICAL AND DETAIL 21/12.		SUPPLY AND INSTALL OVERFLOW SCUPPER. REFER TO DETAIL 6/10.
	EXTENT AND DIRECTION OF TAPERED INSULATION		SUPPLY AND INSTALL SACRIFICIAL MEMBRANE PLY AND RUBBER WALKWAY PADS WHERE INDICATED
	EXISTING MASONRY CHIMNEY TO REMAIN. REFER TO DETAIL 24/13.		SUPPLY AND INSTALL CARPENTRY SERVICE CURB. SEE DETAIL 22/12.
	SUPPLY AND INSTALL ROOFTOP DUCTWORK ON PREMANUFACTURED DUCT SUPPORTS. REFER TO DETAIL 26/13.		
	REINSTALL EXISTING GUY WIRES TO ORIGINAL LOCATION		

SCUPPER LOCATIONS TO BE CONFIRMED BY UCDSB. LOCATIONS TO BE CONFIRMED ON SITE PRIOR TO CONSTRUCTION TO ENSURE THEY ARE NOT OVER DOORS.



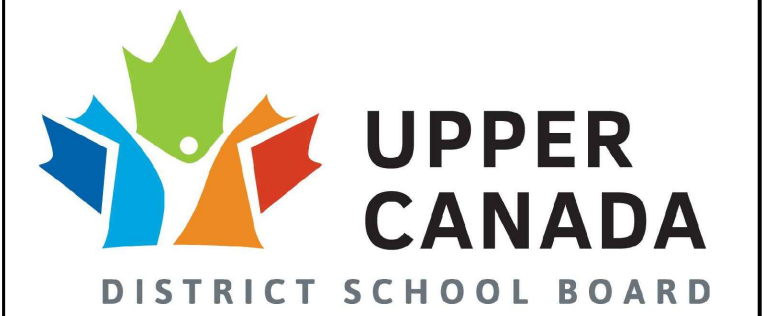
R1  
5  
1:5  
TYPICAL ROOF ASSEMBLY R1

EXISTING WALL MOUNTED CHIMNEY TO REMAIN. REMOVE UPPER WALL BRACKET TO COMPLETE THE WORK AND REINSTALL UPON COMPLETION. SUPPORT CHIMNEY IN PLACE AS REQUIRED



- Notes:
- CONTRACTOR IS RESPONSIBLE TO VERIFY ALL DIMENSIONS AND CONFIRM EXISTING CONDITIONS.
  - NOTIFY CONSULTANT IMMEDIATELY OF ANY DEVIATIONS FROM ASSUMED EXISTING CONDITIONS AS THEY ARE ENCOUNTERED ON SITE.
  - TEMPORARILY REMOVE AND SUPPORT ELECTRICAL BOXES AND CONDUIT RUNNING ALONG PARAPETS AND ON ROOF SURFACES. REINSTATE UPON COMPLETION AND RE-SECURE AS REQUIRED.
  - DRAWINGS ARE NOT TO BE SCALED.
  - THE PROJECT CONSTRUCTOR IS RESPONSIBLE FOR RETAINING/COORDINATING SUB-TRADES, AND SUPPLY AND INSTALLATION OF ALL EQUIPMENT AND MATERIALS AS REQUIRED TO COMPLETE THE WORK AS OUTLINED IN THE RE-ROOFING TENDER DOCUMENTS.

RECORD DRAWINGS:  
THE REVISIONS TO THESE DOCUMENTS, REFLECTING SIGNIFICANT CHANGES AND AS-FOUND CONDITIONS DURING CONSTRUCTION, ARE BASED ON DATA FURNISHED BY THE CONTRACTOR. THE CONSULTANT SHALL NOT BE HELD RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF THE INFORMATION PROVIDED BY THE CONTRACTOR.



105-1020 Bayridge Drive, Kingston, Ontario, K7P 2S2  
T: 613-767-8930 | F: 613-831-3812 | www.fsaeng.com

REV #	DATE	DESCRIPTION
5	2025-04-03	RECORD DRAWINGS
5	2024-05-17	FOR PERMIT
3	2024-04-25	FOR ADDENDUM 1
3	2024-04-04	FOR TENDER
2	2024-03-07	FOR 99% REVIEW
1	2023-12-12	FOR 60% REVIEW

Client: UPPER CANADA DISTRICT SCHOOL BOARD

Project: THOUSAND ISLAND SECONDARY SCHOOL  
STRUCTURAL & ROOF REPLACEMENT

Project #: FSA Project #: 23256DK

## PARTIAL ROOF PLAN

Address of Project: 2510 Parkdale Ave Brockville, ON K6V 3H1	Scale: 1:200 Drawn: RRC Designed: DJA Checked: DJA	Page Number: <b>5</b>
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Date: 2023-11-10 | 23256DK-1.dwg