

UCDSB project no. 25-101  
SOUTH GRENVILLE DHS  
ROOF REPLACEMENT  
AND IMPROVEMENTS

1000 EDWARD ST N, PRESCOTT, ON K0E 1T0

SPECIFICATIONS  
**ISSUED FOR TENDER**  
APRIL 10, 2026

Volume 2 of 2  
Mechanical and Electrical Specifications

SOUTH GRENVILLE DHS  
ROOF REPLACEMENT  
AND IMPROVEMENTS  
1000 EDWARD ST N, PRESCOTT, ON K0E 1T0

**N45 ARCHITECTURE INC.**

7th floor 71 bank street ottawa on k1p 5n2 t.613.224.0095 f.613.224.9811

70 Years of Mechanical & Electrical Engineering Excellence



**1000 Edward St. North - Prescott, ON  
South Grenville District High School  
Architectural Services - UCDSB - RFQ #25-101**

**MECHANICAL SPECIFICATION  
Issued for Tender R1**



**GWAL 2025-633**  
April 13, 2026

**Prepared By:**

Petar Azdajic, B.Eng. | Intermediate Mechanical Designer

**Reviewed By:**

Steve Hamilton, P.Eng. | Director, Mechanical Engineer

<b><u>SECTION</u></b>	<b><u>TITLE</u></b>	<b><u>PAGES</u></b>
<b><u>DIVISION 20 - COMMON REQUIREMENTS FOR MECHANICAL</u></b>		
SECTION 20 05 01	MECHANICAL GENERAL REQUIREMENTS .....	14
SECTION 20 05 49.01	SEISMIC RESTRAINT SYSTEMS (SRS) FOR MECHANICAL SYSTEMS .....	4
SECTION 20 31 00	ACCESS DOORS FOR MECHANICAL SYSTEMS .....	1
<b><u>DIVISION 22 - PLUMBING</u></b>		
SECTION 22 11 16	DOMESTIC WATER PIPING – COPPER & STAINLESS STEEL .....	4
SECTION 22 13 18	DRAINAGE WASTE & VENT PIPING - PLASTIC .....	3
SECTION 22 42 01	PLUMBING SPECIALTIES AND ACCESSORIES .....	5
SECTION 22 42 03	PLUMBING FIXTURES AND TRIM .....	3
<b><u>DIVISION 23 - HEATING, VENTILATING AND AIR-CONDITIONING (HVAC)</u></b>		
SECTION 23 05 05	INSTALLATION OF PIPEWORK .....	3
SECTION 23 05 19	THERMOMETERS AND PRESSURE GAUGES .....	2
SECTION 23 05 23	VALVES .....	4
SECTION 23 05 29	BASES, HANGERS, AND SUPPORTS .....	5
SECTION 23 05 53	IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT .....	4
SECTION 23 05 93	TESTING, ADJUSTING AND BALANCING (TAB) OF MECHANICAL SYSTEMS .....	6
SECTION 23 07 13	THERMAL INSULATION FOR DUCTING .....	4
SECTION 23 07 15	THERMAL INSULATION FOR PIPING .....	5
SECTION 23 08 01	PERFORMANCE VERIFICATION MECHANICAL PIPING SYSTEMS .....	2
SECTION 23 08 02	CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS .....	3
SECTION 23 21 13.02	HYDRONIC SYSTEMS: STEEL .....	3
SECTION 23 21 14	HYDRONIC SPECIALTIES .....	4
SECTION 23 21 23	PUMPS - HYDRONIC SYSTEMS .....	4
SECTION 23 31 13.01	DUCTWORK - LOW PRESSURE - METALLIC TO 500 PA.....	4
SECTION 23 33 00	DUCT ACCESSORIES .....	2
SECTION 23 33 14	DAMPERS - BALANCING .....	1
SECTION 23 33 53	ACOUSTIC DUCT LINING .....	2
SECTION 23 34 23	COMMERCIAL FANS .....	3
SECTION 23 37 13	GRILLES, REGISTERS, & DIFFUSERS .....	2
SECTION 23 44 01	DUST COLLECTOR .....	3
SECTION 23 74 00	PACKAGED OUTDOOR HVAC EQUIPMENT .....	5

**DIVISION 25 - INTEGRATED AUTOMATION**

SECTION 25 01 11 EMCS: START-UP, VERIFICATION AND COMMISSIONING .....	5
SECTION 25 01 12 EMCS: TRAINING .....	2
SECTION 25 05 01 EMCS: GENERAL REQUIREMENTS .....	5
SECTION 25 05 02 EMCS: SUBMITTALS AND REVIEW PROCESS .....	3
SECTION 25 05 03 EMCS: PROJECT RECORD DOCUMENTS.....	2
SECTION 25 05 54 EMCS: IDENTIFICATION .....	2
SECTION 25 05 60 EMCS: FIELD INSTALLATION.....	6
SECTION 25 08 20 EMCS: WARRANTY AND MAINTENANCE .....	3
SECTION 25 30 02 EMCS: FIELD CONTROL DEVICES.....	5
SECTION 25 90 01 EMCS: SITE REQUIREMENTS, APPLICATIONS AND SYSTEMS SEQUENCES OF OPERATION .....	3

## **RELATED SECTIONS**

1. This section shall be read in conjunction with all mechanical sections, and all other disciplines related to the project.

## **GENERAL**

1. All references to OBC/NBC shall be to the version in effect as at the time of the permit application.
2. All references to codes/standards/etc. throughout the specification shall be to the version referenced by OBC/NBC (whichever is applicable) as at the time of the permit application. References to codes/standards/etc. that are not referenced by OBC/NBC shall be to the latest version as at the time of tender.

## **REFERENCES**

1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
  - a. ASHRAE 90.1 , Energy Standard for Buildings Except Low-Rise Residential Buildings.
2. Ontario Regulation
  - a. ONTARIO OBC, Ontario Building Code Compendium.
3. National Fire Protection Association (NFPA)
  - a. NFPA (Fire) 13 , Installation of Sprinkler Systems.
4. National Research Council Canada
  - a. NRCC NBCC, National Building of Canada.

## **EQUIPMENT**

1. General:
  - a. Mechanical equipment that is not regulated by the Green Energy Act, shall carry a permanent label installed by the manufacturers stating the equipment complies with the requirement of ASHRAE 90.1.
  - b. The minimum equipment efficiency, standard rating and operating conditions shall be as per ASHRAE 90.1, superseded by Ontario Building Code (OBC) Supplementary Standard SB -10, unless indicated otherwise on contract documents. The higher of the energy efficiencies of the listed equipment shall prevail.
  - c. Provide new materials and equipment of proven design, quality and of current models with published ratings for which replacement parts are readily available.
  - d. Uniformity: Use product of one manufacturer unless otherwise specified, for equipment or material of the same type of classification.
2. Installation:
  - a. Unions, flanges and/or couplings: provide for ease of maintenance and disassembly.
  - b. Space for servicing, disassembly and removal of equipment and components: provide as recommended by manufacturer, Code or as indicated; whichever is the more stringent.

- c. Equipment drains pipe to floor drains in a manner which is non-obstructing.
- d. Install equipment, rectangular cleanouts, and similar items parallel to or perpendicular to building lines.
- e. Unless otherwise specified, follow manufacturer's recommendations for safety, adequate access for inspection, maintenance, and repairs.
- f. Permit equipment maintenance and disassembly with minimum disturbance to connecting piping and duct systems without interference with building structure or other equipment.
- g. Lubrication: Provide accessible lubricating means for bearings, including permanent lubrication "Lifetime" bearings. Extended grease nipples to be supplied.

### **ANCHOR BOLTS AND TEMPLATES**

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

### **TRIAL USAGE**

1. Engineer may use equipment and systems for test purposes or for continuity of operation prior to acceptance. Supply labour, material, and instruments required for testing & operation.

### **PROTECTION OF OPENINGS**

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

### **ELECTRICAL**

1. Electrical work to conform to Division 26 including the following:
  - a. Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems. Refer to Division 26 for quality of materials and workmanship.
2. Any costs associated with deviation of mechanical equipment rating affecting electrical Division 26 shall be carried by the mechanical contractor.
3. All control wiring & conduit associated with EMCS & HVAC controls shall be provided by Divisions 20, 21, 22, 23 & 25 including power wiring to all control panels & other field mounted control devices. Emergency power circuits are provided by Division 26 in the vicinity of the power source.

### **PAINTING**

1. To Section 09 91 23 - Interior Painting.
2. Apply at least one coat of corrosion resistant primer paint to ferrous supports and site fabricated work.
3. Prime and touch up marred finished paintwork to match original. Use primer or enamel to match original. Do not paint over nameplates.
4. Restore to new condition, finishes which have been damaged too extensively to be merely primed and touched up.

5. Hangers, supports, and equipment fabricated from ferrous metals shall be given at least one coat of corrosion resistant primer paint before shipment to job site.
6. Touch-up damaged surfaces of all mechanical equipment and materials, to the satisfaction of Engineer. Use primer or enamel to match original. Do not paint over nameplates.

## **SPARE PARTS**

1. Furnish spare parts, indicated in various section, and as follows:
  - a. One casing joint gasket for each size pump.
  - b. One head gasket set for each heat exchanger.
  - c. One glass for each gauge glass.
  - d. One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
  - e. Six fusible links for each type of fire damper.
  - f. Provide other spare parts as indicated in equipment description. Reference Spare Parts List in Appendix 'B'.

## **SPECIAL TOOLS**

1. Provide one set of special tools required to service equipment as recommended by manufacturers.

## **WASTE MANAGEMENT AND DISPOSAL**

1. Waste Reduction Workplan (WRW):
  - a. Perform work in accordance with project's WRW. If one does not exist, provide the following:
    - .1 Identify opportunities for reduction, re-use and/or recycling of materials.
    - .2 Post workplan or summary where workers on site are able to review its content.
2. Materials Source Separation Program (MSSP):
  - a. Perform all work in accordance with project's MSSP. If one does not exist, provide the following:
    - .1 Provide containers for collection of re-usable and/or recyclable materials.
    - .2 Transport off-site salvaged materials to authorized recycling facility or to users of material for re-use.
3. Disposal of Waste:
  - a. Disposal of waste, volatile materials, mineral spirits, oil, paint thinner, etc. into waterways, storm or sanitary sewers is prohibited.
4. Storage, Handling and Protection:
  - a. Store materials for re-use in a secure area as directed by project manager, where they will not be damaged. Provide protection of materials, as necessary.

- b. Unless otherwise specified, removed materials become the Contractor's property. Contractor shall be responsible for transport & delivery of non-salvageable items to a licensed disposal facility.

## **DEMONSTRATION AND OPERATING AND MAINTENANCE INSTRUCTIONS**

1. Supply tools, equipment, and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, troubleshooting, and servicing of all systems and equipment during regular work hours, prior to acceptance.
2. Where specified elsewhere in Divisions 20, 21, 22, 23 & 25, manufacturers to provide demonstrations and instructions.
3. Use operation and maintenance manual, as-built drawings, audio visual aids, etc. as part of instruction materials.
4. Instruction duration time requirements as specified in appropriate sections.
5. Where deemed necessary, Owner may record these demonstrations on video tape for future reference.
6. Furnish trained instructors to instruct Owner's operating staff in the operation, maintenance, and adjustment of all mechanical equipment; and instruct personnel on any changes to or modifications of any equipment made under terms of the guarantee.
7. The instructions shall take place during regular working hours before systems are accepted and turned over to Owner's staff.
8. Ensure that the Owner's operating personnel have received and been given opportunity to review the Operating and Maintenance Manuals prior to commencing instruction. Allow two full days on site for review of these manuals with Owner's personnel and for their instruction in operation and maintenance of all mechanical equipment.

## **CLOSEOUT SUBMITTALS**

1. Submit operation and maintenance data for incorporation into manual in accordance with Div. 01 - General Requirements.
2. Operation and maintenance manual (O&M) to be approved by, and final copies deposited with, Engineer before final inspection.
3. For all equipment listed in O&M manuals provide a schedule detailing the supplied component, name, address & phone no. of equipment vendor, parts supplier, and warranty agent.
4. Operation data to include:
  - a. Control schematics for each system including environmental controls.
  - b. Description of each system and its controls.
  - c. Description of operation of each system at various loads together with reset schedules and seasonal variances.
  - d. Operation instruction for each system and each component.
  - e. Description of actions to be taken in event of equipment failure.
  - f. Valves schedule and flow diagram.
5. Maintenance data shall include:



- a. Servicing, maintenance, operation, and trouble-shooting instructions for each item of equipment.
  - b. Data to include schedules of tasks, frequency, tools required and task time.
- 6. Performance data to include:
  - a. Equipment manufacturer's performance data sheets with point of operation as left after commissioning is complete.
  - b. Equipment performance verification test results.
  - c. Special performance data as specified elsewhere.
  - d. Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing.
- 7. Approvals:
  - a. Submit electronic format (pdf) copy of draft Operation and Maintenance Manual to Engineer for approval. Submission of individual data will not be accepted unless so directed by Engineer. PDF file to include tabs to allow navigation to each section of the manual.
  - b. Make changes as required and re-submit as directed by Engineer.
  - c. Upon acceptance by Engineer submit one (1) electronic format (pdf) and three (3) hardcopies of O&M manuals to Owner.
- 8. Additional data:
  - a. Prepare and insert additional data into operation and maintenance manual when the need becomes apparent during demonstrations and instructions specified above.

## **ACCEPTABLE PRODUCTS**

- 1. Design is based on first manufacturer's name under acceptable products. Subsequent manufacturer's names indicate that those named are acceptable providing they meet specifications and space limitations and are subject to acceptance by Shop Drawing Review.
- 2. All manufacturers and manufacturer representatives shall separate pricing by major piece of equipment, equipment type, and/or service when submitting to bidding contractors. Lump sum values are not to be submitted to contractors. Manufacturer & representatives providing only lump sum pricing will be disqualified from tender.

## **SHOP DRAWINGS AND PRODUCT DATA**

- 1. Submit single electronic (pdf) copy of shop drawings and product data along with transmittal, in accordance with Div. 01 - General Requirements. Hard copy shop drawings shall not be accepted.
- 2. Shop drawings and product data shall show:
  - a. Mounting arrangements.
  - b. Operating and maintenance clearances. e.g. access door swing spaces.
- 3. Shop drawings and product data shall be accompanied by:
  - a. Detailed drawings of bases, supports, and anchor bolts.

- b. Acoustical sound power data, where applicable.
  - c. Points of operation on full equipment performance curves.
  - d. Manufacturer to certify as to current model production.
  - e. Certification of compliance to applicable codes.
4. The information to be indicated on manufacturers' shop drawings submitted for review shall include the following:
- a. General arrangement drawings showing component parts. Where the equipment proposed, or a component part thereof, includes modifications to a manufacturers' standard to meet the requirements of a specification, a complete assembly drawing must be submitted.
  - b. Overall dimensions, roughing-in dimensions, and clearance dimensions of all major components.
  - c. Mounting details and dimensions.
  - d. Complete certified performance data for the specified application with particular reference to rate of flow, operating pressure, and temperatures, entering and leaving conditions of air or fluid, operating weights, operating limitation, electrical characteristics, and BHP requirements.
  - e. Gauge of fabricated material and finish specification.
  - f. Vibration isolators and resilient hangers stating locations and weight distribution.
  - g. Electrical wiring diagrams, control panel boards, motor test data, motor starters and controls for electrically operated equipment furnished by mechanical trades.
5. Review of shop drawings or detail drawings will not relieve the obligation of ensuring that the equipment, materials, or layouts meet the functional requirements of the specifications, and that all necessary mounting space and clearance requirements are met. Thus, the Engineer's review is for assistance only.
6. No equipment will be accepted on the job site without shop drawings having been reviewed by the Engineer.

## **CLEANING**

1. Prior to turnover to client, clean interior and exterior of all new systems. Replace all air & hydronic filters on new & modified systems. Vacuum interior of new and modified ductwork and air handling units.

## **AS-BUILT DRAWINGS**

1. Site records:
  - a. Mechanical sub-contractor shall mark all changes as work progresses and as changes occur.
  - b. On a weekly basis, transfer information to record set of documents, revising to show all work as actually installed.
  - c. Use different colour waterproof ink for each service.
  - d. Make available for reference purposes and inspection at all times.

2. As-built drawings:

- a. Prior to start of Testing, Adjusting and Balancing (TAB), finalize production of as-built drawings.
- b. Identify each drawing in lower right hand corner in letters at least 12 mm high as follows:  
- "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (date).
- c. Engineer to submit AutoCAD or Revit files (as applicable) of mechanical drawings to contractor. Contractor shall modify CAD Drawings disks in accordance with Engineer CAD standards to reflect mechanical systems as installed.
- d. Submit electronic CAD files & hard copy to Engineer for approval and make corrections as directed.
- e. TAB to be performed using as-built drawings.
- f. Following approval, submit completed hard copy as-built drawings with Operating and Maintenance Manuals. Provide complete electronic as-built drawings in PDF and AutoCAD formats as well.

3. Submit copies of as-built drawings for inclusion in final TAB report.

**CONFLICT/CO-ORDINATION DRAWINGS**

1. For congested areas, prior to installation the contractor shall prepare interference drawings indicating proposed location of all systems & equipment including ductwork, piping, fans, diffusers, VAV boxes, conduits, lighting fixtures, etc. Prior to installation the contractor shall submit the drawings to the Engineer for review.
2. Architectural, structural, and electrical outlines may be shown to assist in coordination of work; confirm final arrangements before layout of mechanical work.
3. Do not scale.
4. Except where dimensioned, drawings indicate general mechanical layouts only.
5. Provide field drawings to show relative positions of various services. Obtain approval before beginning work. As a minimum provide layout/coordination drawings for mechanical rooms & corridor ceilings. Drawings must show coordination between all equipment and systems within the given space. All sub-trades to coordinate their work in conjunction with others.
6. Within six (6) weeks of Letter of Intent, mechanical & electrical trades to verify that proposed rooms, shafts, chases, reflected ceiling elevations, etc. provide adequate space for the installation of mechanical & electrical systems. This is to identify if there are any spatial shortcomings and to give adequate time for construction manager, consultants, and trades to make any dimensional changes and to make clear to all trades where items are to be installed. Installation and layout will not be on a first come first layout basis.
7. Request for information (RFI) to be submitted, if necessary, with contractor's proposed solution & issue of concern. RFI's must be submitted with proposed solution and clearly identify the issues or conflicts so Engineer can respond appropriately.
8. If this procedure is not followed the contractor shall be responsible for all modifications required to integrate the systems & equipment.

9. When requested by the City, contractor shall provide a single line isometric drawing of the proposed plumbing vent system.
10. Provide sleeving drawings showing all proposed sleeves for mechanical services, for review and approval by the architect & engineers. Sleeves shall be sized and dimensioned from nearest grid lines in both directions. Sleeving drawings shall be provided well in advance of slab pours to allow sufficient time for reviews and revisions as per comments from architect and engineers. Slab pouring shall not proceed until the associated sleeving drawing is approved. Sleeving drawings shall be fully coordinated with general contractor and all other trades. Any remedial work caused by failure to produce proper sleeving drawings shall be completed at the contractor's expense.

## **FEES AND PERMITS**

1. Pay all fees and obtain all permits, taxes relating to the mechanical scope of work.
2. Additional costs associated with natural gas service shall be carried in the Div. 01 - General Requirements Section 01 21 10 - Allowances.
3. Water entry service charges associated with City water meter shall be carried in Div. 01 General Requirements Section 01 21 10 - Allowances. Obtain meter from site services contractor and install in accordance with City standards.
4. Contractor shall apply for and coordinate all required TSSA inspections/certifications. Contractor shall also complete and submit all forms required by TSSA and pay all associated fees.

## **FIRE ALARM BYPASS**

1. Contractor to pay all costs associated with fire alarm bypass as required to perform mechanical work.

## **WARRANTY**

1. Unless indicated otherwise provide one (1) year warranty starting at substantial completion for all new systems including materials, equipment & labour.

## **LOCATION OF MECHANICAL EQUIPMENT**

1. Allow for 1500 mm of adjustment for exact location of air handling units, pumps, ducts, piping, etc. at no extra cost or credit.

## **ELECTRONIC DRAWINGS**

1. Goodkey, Weedmark & Associates Limited will agree to supply the mechanical drawings in the form of electronic documents for the project to the User for the convenience of the User in carrying out its work. The User shall sign a License Agreement before drawings will be released.

## **CUTTING, PATCHING & CORING**

1. Provide cutting, patching, and coring of all walls, ceiling & concrete slabs and other surfaces as required for mechanical work. Check with Owner or Building Management prior to core drilling and cutting of structure regarding building requirements and policies. Provide notification, clearance & protection.
2. The following procedure shall be followed for cutting & core drilling:

- a. Contractor to coordinate and summarize all new cores and openings in building structure. Contractor to investigate on site and locate any existing available hole which may be re-used for new systems.
  - b. Contractor to prepare a layout sketch showing all existing openings & holes and required new openings & holes, with size and locations to the closest grid line in both directions and submit for review and approval by the architect & structural engineer.
  - c. Structural engineer to provide written report outlining acceptance of the openings, as well as specific requirements for reinforcing at each location.
  - d. Contractor to proceed with reinforcing tracing as per report and scanning for electrical conduit. Scanning to be completed using ground penetrating Radar (GPR) technology.
  - e. Contractor shall identify at each location prior to coring and cutting the location, direction and layer of each reinforcing bar and conduit.
  - f. Any core or opening where reinforcing steel was cut during the cutting & coring process must be retained on site, and the Contractor must inform the engineer with the following information: size of the reinforcing bar, reinforcing layer location (top steel or bottom slab steel) and direction of the bar (east - west or north - south).
3. Patch and make good surfaces cut, damaged or disturbed, to Engineer's approval. Match existing material, colour, finish, and texture or as indicated otherwise.
  4. Provide dust tight screens or partitions to localize dust generating activities and for protection of finished areas of work, workers and public.

## **MECHANICAL COST BREAKDOWN**

1. Upon award of contract, provide mechanical cost breakdown as per attached schedules for engineer's review and for progress billing purposes.
2. Costs such as site trailers, mobilization, shop drawings, engineering, etc. to be included as part of material and labour for each piece of equipment.
3. Controls programming and commissioning to be billed upon completion of commissioning.
4. Fire protection engineering costs to be included as part of material and labour costs.
5. Closeout documents including O&M manuals, as-built drawings, approved air & hydronic TAB reports, seismic letters, NFPA letters, etc. shall constitute 5% of the total mechanical construction cost and shall be approved as a single lump sum line item after submission to and final acceptance by Engineer. Contractor to indicate cost as a separate line item in Progress Billing.
6. Proposed billings to be submitted a minimum of fourteen (14) calendar days prior to submission of first billing, for review and approval by Engineer.
7. Equipment costs are to be broken down by system/equipment groupings and by floor and submitted with proposed billing submittal.

## **FINAL INSPECTION**

1. Do not request final inspection until:
  - a. Deficiencies are less than 25 items.
  - b. All systems have been tested and are ready for operation.

- c. All air & water balancing has been completed as applicable.
  - d. The Owner's operating personnel have been instructed in the operation of all systems and equipment.
  - e. The complete operation and maintenance data books have been delivered to the Engineer.
  - f. All inspection certificates have been furnished including but not limited to seismic certification, NFPA (Fire) 13 certification, City's final plumbing inspection.
  - g. All record drawings have been completed and approved.
  - h. All fire extinguishers have been installed.
  - i. All spare parts and replacement parts have been provided and receipt of same acknowledged.
  - j. The cleaning up is finished in all respects.
  - k. Upon completion of above, contractor to request in writing for final site review with a minimal 72-hour notification.
2. Final installation shall be subject to the approval of the Engineer.

## **COMMISSIONING**

1. Commissioning of the mechanical systems shall be in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements.
2. Commissioning of the mechanical systems shall be in accordance with Section 25 01 11 - EMCS: Start-Up, Verification and Commissioning.
3. Commissioning of the mechanical systems shall be in accordance with the commissioning specification. Mechanical contractor shall assist on all commissioning requirements.
4. Items to include the following:
  - a. Plumbing:
    - .1 Domestic recirculation pumps
    - .2 Domestic hot water heater
  - b. Hydronic Heating:
    - .1 Boilers
    - .2 Circulation pumps
  - c. Ventilation:
    - .1 Ventilation for Penthouse
    - .2 Washroom exhaust
    - .3 Balancing
    - .4 Rooftop units
  - d. Fire Suppression:
    - .1 Sprinklers

- .2 Fire pump/jockey pump & standpipe flow test
  - e. Controls:
    - .1 HVAC
    - .2 Alarms
    - .3 Operator workstation (OWS)
  - f. Mechanical contractor shall assist on all the INTEGRATED TESTING OF FIRE AND LIFE SAFETY SYSTEMS. Refer to Section 01 91 25 - Integrated Systems Testing.

**PROGRESS BILLING-MECHANICAL CONTRACT PRICE \$**

1.

<i><b>Fire Protection</b></i>		<i><b>Total Contract Amount \$</b></i>	<i><b>% to Date</b></i>	<i><b>Total to Date \$</b></i>	<i><b>Previous Amount Invoiced \$</b></i>	<i><b>Amount this Claim \$</b></i>	<i><b>Balance Remaining \$</b></i>
<i>Mobilization – Admin., Site Set-up</i>							
<i>Engineering</i>							
<i>Fabrication</i>							
<i>Sleeving</i>	<i>Material</i>						
	<i>Labour</i>						
<i>Sprinklers</i>	<i>Material</i>						
	<i>Labour</i>						
<i>Specialty</i>	<i>Material</i>						
	<i>Labour</i>						
<i>Pumps</i>							
<i>Close-out Documentation (5%)</i>							
<b>TOTAL ORIGINAL CONTRACT AMOUNT</b>							
<i>Change Orders</i>							
<i>Architect's CO #</i>	<i>GWAL CCO or SI #</i>						
<i>#</i>	<i>#</i>						
<i>#</i>	<i>#</i>						
<i>Total Change Order Amount</i>							
<b>TOTAL CONTRACT AMOUNT</b>							

*NOTE: Change Orders that do not reference the Architect's Change Order number and Goodkey, Weedmark's Contemplated Change Order (CCO) or Site Instruction (SI) number will not be reviewed.*

2.

<b>HVAC</b>		<b>Total Contract Amount \$</b>	<b>% to Date</b>	<b>Total to Date \$</b>	<b>Previous Amount Invoiced \$</b>	<b>Amount this Claim \$</b>	<b>Balance Remaining \$</b>
<i>Mobilization – Admin., Site Set-up</i>							
<i>Drafting &amp; Coordinating</i>							
<i>Sleeving</i>	<i>Material</i>						
	<i>Labour</i>						
<i>Sheet Metal</i>	<i>Material</i>						
	<i>Labour</i>						
<i>Grilles, Diffusers</i>	<i>Material</i>						
	<i>Labour</i>						
<i>Silencers</i>	<i>Equipment</i>						
	<i>Labour</i>						
<i>R.T.U.'s and Curbs</i>	<i>Equipment</i>						
	<i>Labour</i>						
	<i>Start-up</i>						
<i>Smoke/Fire Dampers</i>	<i>Equipment</i>						
	<i>Labour</i>						
<i>Insulation</i>	<i>Material</i>						
	<i>Labour</i>						
<i>Close-out Documentation (5%)</i>							
<b>TOTAL ORIGINAL CONTRACT AMOUNT</b>							
<i>Change Orders</i>							
<i>Architect's CO #</i>	<i>GWAL CCO or SI #</i>						
<i>#</i>	<i>#</i>						
<i>#</i>	<i>#</i>						



<i>Total Change Order Amount</i>						
<b>TOTAL CONTRACT AMOUNT</b>						

NOTE: Change Orders that do not reference the Architect's Change Order number and Goodkey, Weedmark's Contemplated Change Order (CCO) or Site Instruction (SI) number will not be reviewed.

3.

<b>Controls</b>		<b>Total Contract Amount \$</b>	<b>% to Date</b>	<b>Total to Date \$</b>	<b>Previous Amount Invoiced \$</b>	<b>Amount this Claim \$</b>	<b>Balance Remaining \$</b>
<i>Mobilization – Admin., Site Set-up</i>							
<i>Hardware</i>	<i>Equipment</i>						
	<i>Labour</i>						
<i>Wiring</i>	<i>Material</i>						
	<i>Labour</i>						
<i>Close-out Documentation (5%)</i>							
<b>TOTAL ORIGINAL CONTRACT AMOUNT</b>							
<i>Change Orders</i>							
<i>Architect's CO #</i>	<i>GWAL CCO or SI #</i>						
<i>#</i>	<i>#</i>						
<i>#</i>	<i>#</i>						
<i>Total Change Order Amount</i>							
<b>TOTAL CONTRACT AMOUNT</b>							

NOTE: Change Orders that do not reference the Architect's Change Order number and Goodkey, Weedmark's Contemplated Change Order (CCO) or Site Instruction (SI) number will not be reviewed.

4.

<b>Plumbing</b>		<b>Total Contract Amount \$</b>	<b>% to Date</b>	<b>Total to Date \$</b>	<b>Previous Amount Invoiced \$</b>	<b>Amount this Claim \$</b>	<b>Balance Remaining \$</b>
<i>Mobilization – Admin., Site Set-up</i>							
<i>San. Storm Underground Piping &amp; Floor Drains</i>	<i>Material</i>						
	<i>Labour</i>						
<i>Sleeving</i>	<i>Material</i>						
	<i>Labour</i>						

<i>San. Storm Above Ground Piping &amp; Roof Drains</i>	<i>Material</i>						
	<i>Labour</i>						
<i>Domestic Water Piping</i>	<i>Material</i>						
	<i>Labour</i>						
<i>Heating Water Piping</i>	<i>Material</i>						
	<i>Labour</i>						
<i>Gas Piping</i>	<i>Material</i>						
	<i>Labour</i>						
<i>Plumbing Equipment</i>							
<i>Boilers</i>	<i>Equipment</i>						
	<i>Labour</i>						
	<i>Start-up</i>						
<i>Hot Water Tanks</i>	<i>Equipment</i>						
	<i>Labour</i>						
	<i>Start-up</i>						
<i>Pumps</i>	<i>Equipment</i>						
	<i>Labour</i>						
	<i>Start-up</i>						
<i>Expansion Tanks</i>	<i>Equipment</i>						
	<i>Labour</i>						
<i>Reheat Coils</i>	<i>Equipment</i>						
	<i>Labour</i>						
	<i>Start-up</i>						
<i>Plumbing Fixtures</i>	<i>Equipment</i>						
	<i>Labour</i>						
<i>Insulation</i>							
<i>Domestic</i>	<i>Material</i>						
	<i>Labour</i>						
<i>Heating</i>	<i>Material</i>						

	Labour						
Close-out Documentation (5%)							
TOTAL ORIGINAL CONTRACT AMOUNT							
Change Orders							
Architect's CO #	GWAL CCO or SI #						
#	#						
#	#						
Total Change Order Amount							
TOTAL CONTRACT AMOUNT							

NOTE: Change Orders that do not reference the Architect's Change Order number and Goodkey, Weedmark's Contemplated Change Order (CCO) or Site Instruction (SI) number will not be reviewed.

END OF SECTION

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCES**

1. Ontario Regulation
  - a. ONTARIO OBC, Ontario Building Code Compendium.
2. National Fire Protection Association (NFPA)
  - a. NFPA (Fire) 13, Standard for the Installation of Sprinkler Systems.
  - b. NFPA (Fire) 14, Standard for the Installation of Standpipe and Hose Systems.
  - c. NFPA (Fire) 20, Standard for the Installation of Stationary Pumps for Fire Protection.
3. National Research Council Canada
  - a. NRCC NBCC, National Building Code of Canada.

## **DEFINITIONS**

1. SRS: acronym for Seismic Restraint System.

## **QUALIFICATIONS**

1. Prime mechanical contractor shall engage a Seismic Engineer who shall be responsible for all mechanical sections to ensure all mechanical sections listed in Item 1.1.1 are covered. Prime mechanical contractor shall ensure the Seismic Engineer is a Professional Engineer holding a Certificate of Authorization in the Province of Ontario with a minimum of 5 years' experience in seismic design, and is covered with a minimum of \$2 million Professional Liability Insurance.
2. The Manufacturer shall be a member of VISCMA (Vibration Isolation and Seismic Control Manufacturers Association). They shall have a letter issued to their Supplier confirming that they have reviewed and accepted the engineering practices used by the Seismic Engineer. The letter shall also state that the manufacturer accepts the Supplier to act as their representative for the product.
3. Acceptable Suppliers: HTS Engineering, Master Group, E.H. Price and Capital Seismic. Alternate to be approved by Addendum (only).

## **GENERAL DESCRIPTION**

1. This section covers design, supply, and installation of complete SRS for all systems, equipment specified for installation on this project. This includes fire protection piping & mechanical equipment and systems, both vibration isolated and statically supported.
2. SRS to be fully integrated into & compatible with:
  - a. Noise and vibration controls specified elsewhere in this project specification.
  - b. Structural, mechanical, electrical design of project.

3. During a seismic event, SRS to prevent systems and equipment from causing personal injury and from moving from normal position unless noted otherwise.
4. Specified critical systems as noted below must remain operational during and after a seismic event:
  - a. All systems for buildings as listed in OBC Table 4.1.8.18 - non-structural components.
  - b. Life safety systems.
  - c. Natural gas & fuel oil systems.

## **SUBMITTALS**

1. Submit shop drawings and product data in accordance with Section 20 05 01 - Mechanical General Requirements.
2. Seismic Engineer shall be a Professional Engineer specializing in design of SRS and registered in Province of Ontario. The following submittals shall bear the SRS Design Engineer's seal and signature:
  - a. A complete list of documents reviewed & list of exclusion.
  - b. Full details of design criteria, calculations for all equipment & associated systems.
  - c. A spreadsheet identifying all equipment requiring or not requiring seismic restraints and include all calculations.
  - d. Copy of shop drawings and product data sent to Structural Engineer for review of connection points to building structure.

## **FINAL CERTIFICATION SUBMITTAL**

1. Seismic Engineer shall be a Professional Engineer specializing in design of SRS and registered in Province of Ontario. The following shall bear the SRS Design Engineer's seal and signature:
  - a. SRS installation inspections.
  - b. SRS final certification letter for the project.
2. The Fire Protection Contractors shall be responsible for their respective discipline as it relates to Seismic restraints system. The contractor shall adhere to Section 20 05 49.01 and/or more stringent code (i.e. NFPA (Fire) 13, 14 & 20). Prime mechanical contractor to compile all of the above, review and submit for the record.
3. The final certification letter shall be formatted to identify the following within the body of the letter:
  - a. The date of the final inspection.
  - b. A statement that lists ALL contract documents which were reviewed including but not limited to the mechanical drawings, project change orders, site instructions, etc.
  - c. A statement which clearly identifies any exclusions of scope of service.
  - d. A statement that certifies the complete mechanical seismic installation meets the latest version of OBC & applicable codes & standards.

---

## **MAINTENANCE DATA**

1. Provide maintenance data including monitoring requirements for incorporation into manuals specified in Section 20 05 01 - Mechanical General Requirements.

## **GENERAL**

1. Definitions
  - a. Seismic System: isolation and seismic restraint products supplied by one supplier.
  - b. Manufacturer: manufacturer of the isolation and seismic restraint system.
  - c. Supplier: manufacturers' and seismic engineer's representative
2. Each contractor shall use one Supplier to provide seismic design, isolation, and seismic restraint.
3. Seismic restraints are to be provided for all operational and functional components of building services in accordance with the current Ontario Building Code, and NFPA (Fire) 13, 14 & 20.
4. The contractor shall utilize a Supplier familiar with the design of seismic systems to provide a comprehensive package of isolation and seismic restraint for the project. Provide detailed shop drawings showing the proposed restraint system for all required equipment, piping, and ductwork on the project. The shop drawings submittals shall include all items listed in Item 1.6.
  - a. Acceptable Manufacturers: Kinetics / Vibron, Tecoustics, Mason, Gripple Seismic.
  - b. Alternates to be approved by Addendum only.
5. Cable restraint systems, rod stiffener clamps and seismic isolator capacities to be verified by an independent test laboratory. Connection materials and site specific designs to be by the Seismic Engineer. The Seismic Engineer may specify material and anchors provided by the contractor where this is appropriate. It is the contractors' responsibility to ensure that the Seismic Engineers' requirements and specification have been met.
6. At the completion of the project, the Supplier and the Seismic Engineer shall review the installations on site, and shall prepare a written report, with a sealed letter from the Seismic Engineer, certifying that the installations have been completed in accordance with their design and shop drawings. Refer to item 1.1.

## **SEISMIC FORCE**

1. The Importance Factor for this project is:
  - a.  $I = 1.3$  - Schools.
2. The site classification for seismic site response and shear wave velocity parameters shall be as indicated on structural documents and as recorded in the geotechnical report.

## **INSTALLATION**

1. Install Seismic Restraint Systems in accordance with Seismic Engineer's and manufacturer's recommendations.
2. Install SRS at least 25 mm from all other equipment, systems, services.

3. Co-ordinate connections with all disciplines.

### **INSPECTION AND CERTIFICATION**

1. SRS to be inspected and certified by Manufacturer upon completion of installation.
2. Seismic Design Engineer shall provide written report to Engineer certifying that SRS has been installed in accordance with the SRS drawings. The report shall bear the seal and signature of the SRS Design Engineer.

### **COMMISSIONING DOCUMENTATION**

1. Upon completion and acceptance of certification, hand over to Engineer complete set of construction documents, revised to show "as-built" conditions.

**END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **SHOP DRAWINGS**

1. Submit shop drawings in accordance with Section 20 05 01 - Mechanical General Requirements.
2. Submit catalogue details for each type of door illustrating profiles, dimensions, and methods of assembly.

## **ACCESS DOORS**

1. Supply and install as necessary to gain access to all concealed mechanical equipment for operating, inspecting, adjusting, servicing.
2. Sizes: Except as indicated otherwise, to be minimum sizes as follows:
  - a. For body entry: 600 x 600 mm (24" x 24").
  - b. For hand entry: 300 x 300 mm (12" x 12").
3. Construction: Rounded safety corners, concealed hinges, screwdriver latch, anchor straps, able to open 180°.
4. Materials
  - a. Tiled or marble surfaces and other special areas: Stainless steel with brushed satin or polished finish as directed by Consultant.
  - b. All other areas: Prime coated steel.
5. Fire Rating
  - a. Access doors fire rating to match that of wall, ceiling, or floor the access door is installed in. Coordinate with architectural drawings.

## **EXCLUSIONS**

1. Lay-in tile ceilings. In this instance, use unobtrusive identification locators.

## **INSTALLATION**

1. Installation in accordance with Manufacturer's installation instructions for particular surface.

## **LOCATION**

1. Location: Ensure that equipment is clearly within view and accessible for operating, inspecting, adjusting, servicing without the need for special tools.

## **END OF SECTION**



## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCES**

1. American Society of Mechanical Engineers (ASME)
  - a. ASME B16.15, Cast Bronze Threaded Fittings, Classes 125 and 250.
  - b. ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
  - c. ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
  - d. ASME B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150 and 300.
  - e. ASME B16.51, Copper and Copper Alloy Press-Connect Pressure Fittings.
2. American Society for Testing and Materials (ASTM)
  - a. ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
  - b. ASTM B88M, Specification for Seamless Copper Water Tube (Metric).
  - c. ASTM F492, Standard Specification for Propylene and Polypropylene (PP) Plastic-Lined Ferrous Metal Pipe and Fittings
  - d. ASTM F3226/F3226M-19, Standard Specification for Metallic Press-Connect Fittings for Piping and Tubing Systems.
3. American Water Works Association (AWWA)
  - a. AWWA C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
4. International Association of Plumbing and Mechanical Officials (IAPMO)
  - a. IAPMO PS117 - Press and Nail Connections.
5. International Code Council (ICC)
  - a. ICC LC 1002, Press-connection Fittings for Potable Water Tube and Radiant Heating Systems.
6. National Science Foundation (NSF)
  - a. NSF/ANSI/CAN 61, Drinking Water System Components – Health Effects.
  - b. NSF/ANSI/CAN 372, Drinking Water System Components – Lead Content.

## **PRODUCT DATA**

1. Submit product data in accordance with Section 20 05 01 - Mechanical General Requirements.

## **COPPER PIPING**

1. Domestic hot, cold and recirculation systems, within building.
  - a. Above ground: copper tube, hard drawn, type L: to ASTM B88M.
  - b. Buried or embedded: copper tube, soft annealed, type K: to ASTM B88M, in long lengths and with no buried joints.
  - c. Piping to be made in Canada or USA.

## **FITTINGS FOR COPPER PIPING**

1. Bronze pipe flanges and flanged fittings, Class 150 and 300: to ASME B16.24.
2. Cast bronze threaded fittings, Class 125 and 250: to ASME B16.15.
3. Cast copper, solder type: to ASME B16.18.
4. Wrought copper and copper alloy, solder type: to ASME B16.22.
5. Press fittings:
  - a. Fittings shall conform to ASTM F3226, ICC LC 1002, ASME B16.51, IAPMO PS 117, NSF 61, and NSF 372.
  - b. Fittings ½-inch through 4-inch suitable for use with ASTM B88 copper tube type K, L, or M.
  - c. Fittings ½-inch through 1-1/4-inch suitable for use with annealed copper tube.
  - d. Press Fittings shall have a valid Ontario Building Material Evaluation Commission Authorization (BMEC).
  - e. Cast copper alloy fittings:
    - .1 Alloy: Copper alloy - UNS C12200.
    - .2 Zero lead silicon bronze alloy - C87710 (cast) or C87700 (machined).
    - .3 Shall not be bismuth bronze or yellow brass.
  - f. EPDM elastomeric sealing element shall be peroxide cured for resistance to chloramines.
  - g. Fittings shall be designed to visibly leak during pressure testing if fittings are unpressed.
  - h. 2-1/2 inch through 4-inch fittings shall have stainless-steel grip ring with bidirectional teeth, PBT separator ring, and EPDM sealing element at each press connection.
  - i. Acceptable materials: Viega ProPress.

## **JOINTS**

1. Rubber gaskets, 1.6 mm thick: to AWWA C111/A21.11.
2. Bolts, nuts, hex head, and washers: to ASTM A307, heavy series.
3. Solder: 95/5 lead free solder. No lead content in excess of 0.2%.

4. Polytetrafluoroethylene (PTFE) thread seal tape: for threaded joints.
5. Dielectric connections between dissimilar metals: dielectric fitting to ASTM F492, complete with thermoplastic liner. Bronze or brass ball valves are an acceptable dielectric fitting where applicable.

## **INSTALLATION**

1. Install in accordance with Canadian Plumbing Code, Provincial Plumbing Code and local authority having jurisdiction.
2. Cut square, ream and clean tubing and tube ends, clean recesses of fittings and assemble without binding.
3. Install pipe work in accordance with Section 23 05 05 - Installation of Pipe Work, supplemented as specified herein.
4. Assemble piping using fittings manufactured to ANSI standards.
5. Install DCW piping below and away from DHW and DHWR and other hot piping so as to maintain temperature of cold water as low as possible.
6. Connect to fixtures and equipment in accordance with manufacturer's written instructions unless otherwise indicated.
7. Install isolation valves at all branch take-offs and to isolate each piece of equipment, and as indicated.
8. Allow for pipe offsets due to structure, equipment, duct, or other pipe interferences.
9. Press fittings shall be selected and installed in accordance with manufacturer's installation instructions, using manufacturer's recommended tools. Installers shall be trained by manufacturer.
10. Ensure that all tools used with stainless steel pipe (i.e. brushes, files, grinders and cutting tools) have not come in contact with carbon steel pipe to prevent cross contamination.
11. All grooved components shall be of one manufacturer. Contractor shall verify coupling pressure ratings on Schedule 10 stainless steel prior to installation. Grooved pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Install in accordance with manufacturer's latest recommendations. A factory trained representative shall periodically visit the job site and review the installation for best practices. The installing Contractor shall correct any identified deficiencies. Any product that has been examined and has not met the visual inspection criteria for proper installation must be corrected and re-examined prior to the completion of the project.

## **PRESSURE TESTS**

1. Refer to Section 23 05 05 - Installation of Pipework.
2. Test pressure: greater of 1½ times maximum system operating pressure or 860 kPa.

## **FLUSHING AND CLEANING**

1. Flush entire system for 8 h. Ensure outlets flushed for 2 h. Let stand for 24 h, then draw one sample off longest run. Submit to testing laboratory to verify that system is clean. Let system flush for additional 2 h, then draw off another sample for testing. Submit test results to Engineer.

## **PRE-START-UP INSPECTIONS**

1. Systems to be complete, prior to flushing, testing and start-up.
2. Verify that system can be completely drained.
3. Ensure that pressure booster systems are operating properly.
4. Ensure that air chambers, expansion compensators are installed properly.

## **DISINFECTION**

1. Flush out, disinfect and rinse system to requirements of authority having jurisdiction and to the approval of Engineer.
2. Upon completion, provide laboratory test reports on water quality for Engineer approval.

## **START-UP**

1. Timing: Start up after:
  - a. Pressure tests have been completed.
  - b. Disinfection procedures have been completed.
  - c. Certificate of static completion has been issued.
2. Provide continuous supervision during start-up.
3. Start-up procedures:
  - a. Establish circulation and ensure that air is eliminated.
  - b. Check pressurization to ensure proper operation and to prevent water hammer, flashing and/or cavitation.
  - c. Bring DHW storage tank up to design temperature slowly.
  - d. Monitor DHW and DHWR piping systems for freedom of movement, pipe expansion as designed.
  - e. Check control, limit, safety devices for normal and safe operation.
4. Rectify start-up deficiencies.

## **PERFORMANCE VERIFICATION**

1. Timing:
  - a. After pressure and leakage tests and disinfection completed, and certificate of completion has been issued by authority having jurisdiction.
2. Procedures:

- 
- a. Verify that flow rate and pressure meet Design Criteria.
  - b. TAB DHWR in accordance with Section 23 05 93 - Testing Adjusting and Balancing (TAB) of Mechanical Systems.
  - c. Adjust pressure regulating valves while withdrawal is maximum and inlet pressure is minimum.
  - d. Verify performance of temperature controls.
  - e. Verify compliance with safety and health requirements.
  - f. Check for proper operation of water hammer arrestors. Run 10% of outlets for 10 seconds, then shut off water immediately. If water hammer occurs, replace water hammer arrestor or re-charge air chambers. Repeat for outlets and flush valves.
  - g. Confirm water quality consistent with supply standards, verifying that no residuals remain as a result of flushing and/or cleaning.
3. Reports:
- a. In accordance with Section 20 05 01 - Mechanical General Requirements: Reports, using report forms as specified in Section 20 05 01 - Mechanical General Requirements: Report Forms and Schematics.
  - b. Include certificate of water flow and pressure tests conducted on incoming water service, demonstrating adequacy of flow and pressure.

**END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCES**

1. American Society for Testing and Materials (ASTM)
  - a. ASTM D2564, Specification for Solvent Cements for Poly(Vinyl-Chloride)(PVC) Plastic Piping Systems.
2. Canadian Standards Association (CSA)
  - a. CSA B1800, Thermoplastic Non-pressure Piping Compendium.
3. Ontario Regulation
  - a. ONTARIO OBC, Ontario Building Code Compendium.
4. Underwriters Laboratories of Canada (ULC)
  - a. CAN/ULC S102.2, Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies.

## **PIPING AND FITTINGS**

1. DWV PVC (Polyvinyl Chloride):
  - a. Application: below grade sanitary, storm & vent piping & fittings and above grade where combustible piping is permitted excluding OBC 3.2.6 (High-rise) applications and ceiling plenums.
  - b. Pipe and Fittings: Drain, waste and vent pipe and fittings shall be certified to CSA B1800. When combustible pipe and fittings are used in buildings required to be of noncombustible construction, they shall be listed by ULC to the Standard CAN/ULC S102.2 and clearly marked with the certification logo indicating a flame-spread rating not exceeding 25.
  - c. Acceptable material: IPEX System 15 DWV.
2. Fire & smoke resistant coated DWV PVC (Polyvinyl Chloride) piping & fittings:
  - a. Application: Above grade sanitary, storm & vent piping & fittings where combustible piping is permitted including OBC 3.2.6 High-rise applications and within ceiling plenums.
  - b. Pipe and Fittings: Drain, waste and vent pipe and fittings shall be certified to CSA B181.2 and when used in noncombustible construction, high-rise buildings, and air plenums, they shall be tested and listed in accordance with CAN-ULC-S102.2 and clearly marked with the certification logo indicating a flame-spread rating not exceeding 25 and a smoke-developed classification not exceeding 50.
  - c. Acceptable material: IPEX System XFR 15/50 PVC-DWV.
3. Gasketed DWV PVC (Polyvinyl Chloride):

- a. Application: below grade sanitary & storm piping. Not permitted above grade.
  - b. Pipe and Fittings: Drain & waste pipe and fittings shall be certified to CSA B182.2. Gasketed joints shall withstand hydrostatic pressure levels of at least 100 kPa (15 psi) and a negative pressure of -75 kPa (-11 psi). Pipe connections shall be sealed via factory installed gasket without the need for solvent welding.
  - c. Pipe Thickness:
    - .1 For pipe sizes NPS 4 to 6: DR 28.
    - .2 For pipe sizes NPS 8 and above: DR 35.
  - d. Acceptable material: IPEX Ring-Tite.
4. Solvent Welding:
- a. Solvent cements shall be CSA certified and meet the requirements of ASTM D2564. One-step cement may be used for sizes from NPS 1.5 to 6. Two-step cement must be used in conjunction with primer on larger pipe sizes. Proper solvent cementing procedures must be followed at all times.
  - b. The manufacturer shall be consulted prior to installation for proper solvent welding procedures and proper solvent cement requirements.
5. Expansion/Contraction:
- a. Compensation shall be made to accommodate expansion/contraction on the drainage system. It is recommended that there be compensation on every second floor for the vertical piping system. Consult pipe system manufacturer for specific details regarding approved compensation methods.
6. Compatibility:
- a. To ensure compatibility, performance and material quality, all pipe and fitting drainage system shall be produced by the same manufacturer.
7. Quality Control:
- a. The manufacturer of the pipe and fitting system shall be contacted prior to the installation to obtain precise installation instructions. Site meetings shall be arranged and include the Contractor, Manufacturer and Building Inspector.

## **INSTALLATION**

1. Install in accordance with Canadian Plumbing Code, Provincial Plumbing Code and local authority having jurisdiction.
2. Allow for locating of existing buried sanitary piping prior to excavating for connection of new services.
3. Bedding and backfilling should be in accordance with Russell Township standards and specifications.
4. Plastic pipe shall not be used on pumped sanitary & storm discharge.

---

## TESTING

1. Test in accordance with OBC Part 7 requirements.
2. Pressure test buried systems before backfilling.
3. Hydraulically test to verify grades and freedom from obstructions.
4. Dye Testing:
  - a. The sanitary and storm plumbing systems shall be dye-tested.
  - b. On storm system dye tablets (Fluorescein) shall be mixed with water to the manufacturer's instructions and introduced to each roof drain. The mechanical contractor shall determine if the dissolved fluorescein passed the downstream storm manhole, indicating a "Positive" dye test.
  - c. On the sanitary system, dye tablets (fluorescein) shall be placed in each plumbing fixture or at discretion of certifying engineer. The mechanical contractor shall determine if the dissolved fluorescein passed the downstream sanitary manhole indicating a "Positive" dye test.
  - d. A "Negative" dye test indicates that the building system is not connected to the appropriate system and mechanical contractor shall complete corrective action.
  - e. Dye testing shall be conducted by contractor following below grade rough-in and following the complete above grade installation and finish work.
  - f. Contractor to retain services of an independent professional engineer registered in Ontario to witness Dye testing. Provide letter stamped by engineer certifying successful completion of test.
5. Video Testing:
  - a. Provide video scanning of underground sanitary and storm piping for review and contractor's approval prior to pouring of concrete. Repair deficiencies and re-scan as required. Submit final video to Engineer for record.
  - b. Flush & video scan sanitary and storm piping for contractor's review and approval prior to building turnover. Repair deficiencies and re-scan as required. Submit final video to Engineer for record.

## PERFORMANCE VERIFICATION

1. Cleanouts:
  - a. Ensure accessible and that access doors are correctly located.
  - b. Open, cover with linseed oil and re-seal.
  - c. Verify cleanout rods can probe as far as the next cleanout, at least.
2. Test to ensure traps are fully and permanently primed.
3. Storm water drainage:
  - a. Verify domes are secure.
  - b. Ensure weirs are correctly sized and installed correctly.



- c. Verify provisions for movement of roof system.
- 4. Ensure that fixtures are properly anchored, connected to system and effectively vented.
- 5. Affix applicable label (storm, sanitary, vent, pump discharge etc.) c/w directional arrows every floor or 4.5 m (whichever is less).

**END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCES**

1. American Society of Sanitary Engineering (ASSE)
  - a. ASSE (Plumbing) 1015, Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies.
  - b. ASSE (Plumbing) 1017, Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems.
  - c. ASSE (Plumbing) 1071, Performance Requirements for Temperature Actuated Mixing Valves for Plumbed Emergency Equipment.
2. American Society for Testing and Materials (ASTM)
  - a. ASTM A126, Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
  - b. ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
3. Canadian Standards Association (CSA)
  - a. CSA B64 SERIES, Backflow Preventers and Vacuum Breakers.
  - b. CSA B64.10/B64.10.1, Selection and Installation of Backflow Preventers/Maintenance and Field Testing of Backflow Preventers.
4. NSF International (NSF)
  - a. NSF/ANSI/CAN 61, Drinking Water System Components - Health Effects.
5. Ontario Regulation
  - a. ONTARIO OBC, Ontario Building Code Compendium.
6. Plumbing and Drainage Institute (PDI)
  - a. PDI WH 201, Water Hammer Arresters Standard.
7. Underwriters Laboratories (UL)
  - a. UL 873, Standard for Temperature-Indicating and -Regulating Equipment.

## **SUBMITTALS**

1. Submit shop drawings and product data in accordance with Section 20 05 01 - Mechanical General Requirements.
2. For shop drawings, indicate dimensions, construction details and materials.
3. For product data, indicate dimensions, construction details and materials for items specified herein.

---

## **CLOSEOUT SUBMITTALS**

1. Provide maintenance data for incorporation into manual specified in Section 20 05 01 - Mechanical General Requirements.
2. Data to include:
  - a. Description of plumbing specialties and accessories, giving manufacturers name, type, model, year, and capacity.
  - b. Details of operation, servicing, and maintenance.
  - c. Recommended spare parts list.

## **FLOOR DRAINS**

1. Floor drains and trench drains: to CSA B79.
2. FD-1: Medium duty; epoxy coated cast iron body round, adjustable head, 5" (125 mm) dia. nickel bronze strainer, integral seepage pan, trap priming connection and clamping collar.
  - a. Acceptable material: Watts FD 100C.

## **ROOF DRAINS**

1. RD1: vandal proof, cast aluminum dome with hinged access gate clamped directly to the drain body, 2.3mm pan formed copper drain body, deck flange and straight copper outlet, 9mm stainless steel bolts welded to drain, cast brass stabilizer ring, MJ type connection.
  - a. Acceptable material: Thaler RD-4C with MJ type connection.

## **CLEANOUTS**

1. Cleanout plugs: heavy cast iron male ferrule with brass screws and threaded brass or bronze plug. Sealing-caulked lead seat or neoprene gasket.
  - a. Acceptable material: Watts CO-380, J.R. Smith & Zurn.
2. Access covers:
  - a. Wall access: face or wall type, stainless steel round cover with flush head securing screws, bevelled edge frame complete with anchoring lugs. Acceptable material: Watts, CO 480 (wall), CO 300 (floor), Zurn.
  - b. Floor access: round cast iron body and frame with adjustable secured nickel bronze top cast box with anchor lugs, and.
    - .1 Plugs: bolted bronze with neoprene gasket.
    - .2 Cover for unfinished concrete floors: nickel bronze round, gasket, vandal-proof screws. Acceptable material: Watts CO 200 XHR series, Zurn.
    - .3 Cover for terrazzo finish: polished nickel bronze with recessed cover for filling with terrazzo, vandal-proof locking screws. Acceptable material: Watts CO 200 U-1-6, Zurn ZX-1400-BP-Z.

- .4 Cover for tile and linoleum floors: polished nickel bronze with recessed cover for linoleum or tile infill, complete with vandal-proof locking screws. Acceptable material: Watts CO 200 T-1-6, Zurn.
- .5 Cover for carpeted floors: polished nickel bronze with deep flange cover for carpet infill, complete with carpet retainer vandal-proof locking screws. Acceptable material: Watts CO 200 RC-1-6, Zurn.

## **TRAP SEAL PRIMERS**

1. Type 1: for use on urinal or water closet cold water line.
  - a. Pressure drop activated type, all brass construction with "O" ring seals, 13 mm (NPT ½) male inlet & 13 mm (NPT ½) female outlet drip line connection with viewing holes, and removable fitter screen. Trap primer shall have no adjustment. Operating range shall be 138 kPa (20 psi) to 861 kPa (125 psi). Operates on pressure drop of Minimum 20 kPa (3 psi). One (1) to six (6) drain taps per unit.
  - b. Identify on as-built drawings the location of each trap seal primer.
  - c. Ensure all trap seal primers are accessible for maintenance purposes and are connected to urinal or water closet cold water line. Trap line shall be from top of cold water line and include a service valve. All to be serviceable from access doors.
  - d. Acceptable materials: Mifab M-500, Watts, Zurn Z-1022, Smith controls 2694 distribution unit 2694A.
2. Provide an air gap fitting serving each trap seal primer, if trap seal primer does not include an integral air gap or air space type vacuum breaker in accordance with CSA B64.10.

## **WATER HAMMER ARRESTORS**

1. Copper construction, bellows, or piston type: to PDI-WH201.
  - a. Acceptable material: Watts LF15M2 SERIES, J.R. Smith & Zurn Z-1700.

## **STRAINERS**

1. 860 kPa (125 psi), Y type with 20 mesh, monel, bronze or stainless steel removable screen.
2. NPS 2 and under, bronze body, screwed ends, with brass cap.
  - a. Acceptable material: Wilkins S-XL, Watts equivalent is LF777SI.

## **INSTALLATION**

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

## **FLOOR DRAINS**

1. Floor drains to be installed at lowest point in floor and placed to ensure floor finishing is flush/slightly higher than strainer. Contractor to chip concrete around drains, lower assembly, patch concrete and provide floor finish should the installed elevation be unacceptable to Engineer.

2. Contractor to provide suitable means of protecting floor drains and cleanouts from damage during construction. Contractor to be responsible for turning over facility to Owner with floor drains and strainers in new condition. Damaged material shall be replaced with new at contractor's expense.

## **CLEANOUTS**

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

## **WATER HAMMER ARRESTORS**

1. Install on branch supplies to fixtures or group of fixtures.

## **STRAINERS**

1. Install with sufficient room to remove basket.

## **START-UP**

1. General:
  - a. In accordance with Section 01 91 13 - Commissioning: General Requirements, supplemented as specified herein.
2. Timing: Start-up only after:
  - a. Pressure tests have been completed.
  - b. Disinfection procedures have been completed.
  - c. Certificate of static completion has been issued.
  - d. Water treatment systems operational.
3. Provide continuous supervision during start-up.

## **TESTING AND ADJUSTING**

1. General:
  - a. In accordance with Section 01 91 13 - Commissioning: General Requirements, supplemented as specified herein.
2. Timing:
  - a. After start-up deficiencies rectified.
  - b. After certificate of completion has been issued by authority having jurisdiction.
3. Application tolerances:
  - a. Pressure at fixtures:  $\pm 70$  kPa.
  - b. Flow rate at fixtures:  $\pm 20\%$ .

4. Adjustments:

- a. Verify that flow rate and pressure meet design criteria.
- b. Make adjustments while flow rate or withdrawal is (1) maximum and (2) 25% of maximum and while pressure is (1) maximum and (2) minimum.

5. Roof drains:

- a. Check location at low points in roof.
- b. Check security, removability of dome.
- c. Adjust weirs to suit actual roof slopes, meet requirements of design.
- d. Clean out sumps.
- e. Verify provisions for movement of roof systems.

6. Access doors:

- a. Verify size and location relative to items to be accessed.

7. Cleanouts:

- a. Verify covers are gas-tight, secure, yet readily removable.

8. Strainers:

- a. Clean out repeatedly until clear.
- b. Verify accessibility of cleanout plug and basket.
- c. Verify that cleanout plug does not leak.

9. Commissioning Reports:

- a. In accordance with Section 01 91 13 - Commissioning: Reports, supplemented as specified herein.

10. Training:

- a. In accordance with Section 01 91 13 - Commissioning: Training of O&M Personnel, supplemented as specified herein.
- b. Demonstrate full compliance with Design Criteria.

**END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCES**

1. Canadian Standards Association (CSA)
  - a. CAN/CSA B45 SERIES, Plumbing Fixtures.
  - b. CAN/CSA B125, Plumbing Fittings.
  - c. CSA /ASC B651, Accessible Design for the Built Environment.
2. Ontario Regulation
  - a. ONTARIO OBC, Ontario Building Code Compendium.

## **SHOP DRAWINGS**

1. Submit shop drawings and product data in accordance with Section 20 05 01 - Mechanical General Requirements.
2. Indicate, for all fixtures and trim:
  - a. Dimensions, construction details, roughing-in dimensions.
  - b. Factory-set water consumption per flush at recommended pressure.
  - c. (For water closets, urinals): minimum pressure required for flushing.

## **CLOSEOUT SUBMITTALS**

1. Provide maintenance data including monitoring requirements for incorporation into manuals specified in Section 20 05 01 - Mechanical General Requirements.
2. Include:
  - a. Description of fixtures and trim, giving manufacturer's name, type, model, year, capacity.
  - b. Details of operation, servicing, maintenance.
  - c. List of recommended spare parts.

## **MANUFACTURED UNITS**

1. Fixture piping.
  - a. Hot and cold water supplies to each fixture:
    - .1 Supply stops shall be all brass with full turn brass seams and washer replaceable attachment shall be IPS inlet x compression OD outlet to fixture. All fixtures stop-valves shall be screw driver type.
    - .2 Chrome plated in all exposed places.

b. Waste:

- .1 Cast brass adjustable style P-trap with cleanout on each fixture not having integral trap.
- .2 Chrome plated in all exposed places.
- .3 Sink and lavatory heavy gauge P-traps shall be cast brass adjustable style with 17 ga. seamless brass wall bend. Attachment nuts shall be brass, no zinc allowed. P-traps to be removable/union type or to include cleanout.
- .4 Lavatory strainers shall be chrome-plated cast brass with 17 ga. seamless brass tailpiece.
- .5 All barrier-free lavatories and sinks shall have chrome plated offset tail piece in addition to P-trap with cleanout. Insulate P-trap and hot & cold water pipes with pre-formed & finished surface insulation. Armaflex insulation and tape not acceptable.

2. Fixtures:

- a. Manufacture in accordance with CSA B45.
  - b. All products, where applicable, shall be marked with manufacturer's name or product #.
3. Trim, fittings: manufacture in accordance with CAN/CSA B125.
  4. Number, locations: Architectural drawings to govern.
  5. Fixtures in any one location to be product of one manufacturer and of same type.
  6. Trim in any one location to be product of one manufacturer and of same type unless otherwise indicated.
  7. Reference drawing schedule for configuration and type.

## **CARRIERS**

1. Provide for all wall mounted plumbing fixtures.

## **ROUGHING-IN OF FIXTURES**

1. Rough-in for equipment supplied by other to be complete with valved supplies, wastes and vents, capped and associated fitting piping & reducers.

## **PLUMBING FIXTURES**

1. Reference fixture schedule on drawings.

## **ACCEPTABLE MATERIALS**

1. Water Closets, Urinals, Lavatories, Sinks: American Standard, Crane, Kohler, Comtrac, Zurn, Toto, Moen.
2. Stainless Steel Sinks: Franke, Kindred, Architectural Metal Industries, Novanni.
3. Group Fountains: Bradley, Acorn.



4. Faucets: Delta Commercial, Crane, T&S Brass, Chicago Faucets, American Standard, Moen, Sloan, Zurn.
5. Tub & Shower: American Standards, Maxx, Crane, Longevity, Fiat.
6. Tub & Shower Trim: Delta Commercial, Crane, Powers Symmons, American Standard, Moen, Zurn.
7. Flush Valves: Delta Commercial, Crane, Sloan, Zurn, American Standard, Toto, Moen.
8. Emergency Fixtures: Haws, Bradley, Guardian.
9. Drinking Fountains: Elkay, Haws, Bradley.

## **INSTALLATION**

1. Mounting heights:
  - a. Standard: to comply with manufacturer's recommendations unless otherwise indicated or specified.
  - b. Wall-hung fixtures: as indicated on architectural elevations.
  - c. Physically handicapped: to comply with most stringent of either OBC or CAN/CSA B651.

## **ADJUSTING**

1. Conform to water conservation requirements specified in this section.
2. Adjustments:
  - a. Adjust water flow rate to design flow rates and sensors.
  - b. Adjust pressure to fixtures to ensure no splashing at maximum pressures.
  - c. Adjust flush valves to suit actual site conditions.
3. Checks:
  - a. Water closets: flushing action.
  - b. Aerators: operation, cleanliness.
  - c. Vacuum breakers, backflow preventers: operation under all conditions.

## **END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCES**

1. Canadian General Standards Board (CGSB)
  - a. CAN/CGSB 1.181, Ready-Mixed Organic Zinc-Rich Coating.

## **CONNECTIONS TO EQUIPMENT**

1. In accordance with manufacturer's instructions unless otherwise indicated.
2. Use valves and either unions or flanges for isolation and ease of maintenance and assembly.
3. Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

## **CLEARANCES**

1. Provide clearance around systems, equipment, and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.
2. Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicated (whichever is greater) without interrupting operation of other system, equipment, components.

## **DRAINS**

1. Install piping with grade in direction of flow except as indicated or specified otherwise.
2. Install drain valve at low points in piping systems, at equipment at section isolating valves and at base of all risers.
3. Pipe each drain valve discharge separately to above floor drain. Discharge to be visible.
4. Drain valves: NPS ¾ full port ball valves unless indicated otherwise, with hose end male thread, cap, and chain.

## **AUTOMATIC AIR VENTS**

1. Install automatic air vents at high points of piping systems.
2. Install full port ball at each automatic air vent.
3. Air vents must have minimum connection of 13 mm (½").

## **DIELECTRIC COUPLINGS**

1. General: Compatible with system, to suit pressure rating of system.

2. Locations: Where dissimilar metals are joined.
3. NPS 2 and under: isolating unions or bronze valves.
4. Over NPS 2: Isolating flanges.

## **PIPEWORK INSTALLATION**

1. Screwed fittings to be jointed with polytetrafluoroethylene (PTFE) thread seal tape.
2. Protect openings against entry of foreign material.
3. Install so that equipment can be isolated and removed without interruption to operation of any other equipment or systems.
4. Assemble piping using fittings manufactured to ANSI standards.
5. Weldolets sockolets Saddle type branch fittings may be used on mains if branch line is no larger than half the size of the main. Hole saw (or drill) and ream main so as to maintain full inside diameter of branch line prior to welding saddle. Provide isolation valves at each branch connection.
6. Install exposed piping, equipment, rectangular cleanouts, and similar items parallel or perpendicular to building lines.
7. Install concealed pipework so as to minimize furring space, maximize headroom, conserve space.
8. Except where indicated otherwise, slope piping in direction of flow for positive drainage and venting.
9. Except where indicated, install so as to permit separate thermal insulation of each pipe.
10. Group piping wherever possible and as indicated.
11. Ream pipes, remove scale and other foreign material before assembly.
12. Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
13. Provide for thermal expansion as indicated and specified.
14. Contractor shall carry a structural engineer to design and certify the support system for any piping distribution system exceeding 100 mm (4") or where piping is grouped such that the distributed weight exceeds the building structure limits. (Note: In steel building structure the piping supports shall never be supported by a single joist or off the bottom chord of the joist or truss.

## **SLEEVES**

1. General: Install where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.
2. Material: Schedule 40 black steel pipe.
3. Construction: Foundation walls and where sleeves extend above finished floors - to have annular fins continuously welded on at mid-point.
4. Sizes: 6 mm minimum clearance all round between sleeve and uninsulated pipe or between sleeve and insulation.
5. Installation:

- a. Concrete, masonry walls, concrete floors on grade: Terminate flush with finished surface.
  - b. Other floors: Terminate 25 mm above finished floor.
  - c. Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
6. Sealing:
- a. Foundation walls and below grade floors: Fire retardant, waterproof non-hardening mastic.
  - b. Elsewhere: Provide space for firestopping. Maintain fire rating integrity.
  - c. Sleeves installed for future use: Fill with lime plaster or other easily removable filler.
  - d. Ensure no contact between copper pipe or tube and sleeve.

## **ESCUTCHEONS**

- 1. Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.
- 2. Construction: One piece type with set screws. Chrome or nickel plated brass or type 302 stainless steel.
- 3. Sizes: Outside diameter to cover opening or sleeve. Inside diameter to fit around pipe or outside of insulation if so provided.

## **FLUSHING OUT OF PIPING SYSTEMS**

- 1. In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
- 2. Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.
- 3. Provide test results upon completion and retain written report on status after complete.

## **PRESSURE TESTING OF EQUIPMENT AND PIPEWORK**

- 1. Advise Engineer 48 hours minimum prior to performance of pressure tests.
- 2. PIPework: Fill system with water. Ensure all air is removed from system. Boost pressure to test pressure using water only. Pressurization with air or nitrogen is not allowed. Test to 1½ times normal operating pressure to a maximum of the piping systems working pressure including devices (i.e.: valves, fittings, accessories). Minimum test pressure to be 862 kPa (125 psi).
- 3. Maintain specified test pressure without loss for four (4) hours minimum. Temperature of system to remain constant during entire duration of test.
- 4. Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- 5. Bear costs for repairs or replacement, retesting, and making good. Engineer to determine whether repair or replacement is appropriate.
- 6. Insulate or conceal work only after review and approval of tests results by Engineer.

## **EXISTING SYSTEMS**

1. Connect into existing piping systems at times approved by Engineer.
2. Request written approval 10 days minimum, prior to commencement of work.
3. Be responsible for damage to existing plant by this work.
4. Ensure daily clean-up of existing areas.
5. Cleaning & flushing of new piping to be done prior to making final connection to existing system.  
Refer to Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
6. Provide full size bypass as required to ensure cleaning of piping.

**END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCES**

1. American Society of Mechanical Engineers (ASME).
  - a. ASME B40.100, Pressure Gauges and Gauge Attachments.
2. Canadian General Standards Board (CGSB)
  - a. CAN/CGSB 14.4, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.

## **SHOP DRAWINGS AND PRODUCT DATA**

1. Submit shop drawings and product data in accordance with Section 20 05 01 - Mechanical General Requirements.
2. Indicate on manufacturers catalogue literature the following:
  - a. Thermometers.
  - b. Pressure gauges.
  - c. Ball valve.
  - d. Syphons.
  - e. Wells.

## **MAINTENANCE DATA**

1. Provide maintenance data for incorporation into manual specified in Section 20 05 01 - Mechanical General Requirements.

## **GENERAL**

1. Thermometers and pressure gauges to operate at mid point of scale or range.

## **DIRECT READING THERMOMETERS**

1. Industrial, variable angle type, liquid filled, 125 mm scale length: to CAN/CGSB-14.4.
  - a. Acceptable Materials: Ashcroft, Taylor, Winters, Weiss, H.O. Terice.
2. Low light compatible solar powered display, durable NEMA-5 ABS case, 32 mm (1¼") UNF swivel nut, 19 mm (¾"), NPT with brass thermowell, 6 sec. read interval, -45°C (-50°F ) to 160°C (320°F) range, accurate to 0.1°, switchable metric/imperial scale, vari-angle connection, ±1% accuracy, 4-20 mA output, 90 mm (3.5" ) stem, one (1) year warranty.
  - a. Acceptable material: Winters Model TSD, Therice Model Solar Therm, Precision.

---

## **THERMOMETER WELLS**

1. For copper pipe use copper or bronze. For steel pipe use brass.

## **PRESSURE GAUGES**

1. Liquid filled, 112 mm, dial type: ASME B40.100, Grade 2A, having ½ of 1% accuracy over entire range, stem mounting.
  - a. Acceptable Materials: Ashcroft, Taylor, Winters, Weiss, H.O. Trerice.
2. Provide ball valve and snubber for pulsating operation (pumps).

## **GENERAL**

1. Install so they can be easily read from floor or platform. If this cannot be accomplished, install remote reading units.
2. Install between equipment and first fitting or valve.

## **THERMOMETERS**

1. Install in wells on all piping. Provide heat conductive material for inside of well.
2. Install in locations as indicated and on inlet and outlet of:
  - a. Coils.
  - b. Boilers.
3. Use extensions where thermometers are installed through insulation.

## **PRESSURE GAUGES**

1. Install in following locations:
  - a. Suction and discharge of pumps.
  - b. Inlet and outlet of coils.
  - c. In other locations as indicated.
2. Pressure gauges are to be manifolded between inlet and outlet of device (pump, strainer, HX, etc.) unless otherwise indicated. Provide ball type isolation valve between pressure gauge and device.

## **PRESSURE & TEMPERATURE TEST STATIONS**

1. Install in locations as indicated and on inlet and outlet of:
  - a. Heating coils.
  - b. Hydronic hot water radiation.

**END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCES**

1. American Society of Mechanical Engineers (ASME).
  - a. ASME B1.20.1, Pipe Threads, General Purpose (Inch).
  - b. ASME B16.1, Gray Iron Pipe Flanges and Flanged Fittings, Class 25, 125 and 250.
  - c. ASME B16.34, Valves - Flanged, Threaded and Welding End.
2. American Society for Testing and Materials (ASTM).
  - a. ASTM A126, Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
  - b. ASTM B16/B16M- Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines.
  - c. ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
3. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
  - a. MSS SP-67, Butterfly Valves.
  - b. MSS SP-80, Bronze Gate Globe, Angle and Check Valves.

## **PRODUCT DATA**

1. Submit product data in accordance with Section 20 05 01 - Mechanical General Requirements.
2. Submit data for all valves specified in this section.

## **CLOSEOUT SUBMITTALS**

1. Submit maintenance data for incorporation into manual specified in Section 20 05 01 - Mechanical General Requirements.

## **ACCEPTABLE MANUFACTURERS**

1. Refer to Acceptable Products Table in Part 3 of this section.

## **GENERAL**

1. All valves of the same type to be from one manufacturer.
2. All valves to have CRN registration numbers.
3. All domestic water valves shall be lead-free versions of valves.
4. All valves shall be selected such that they will not be operated outside of their certified temperature & pressure range.



---

## **CHECK VALVES**

1. NPS 2 and under, bronze swing type, bronze disc:
  - a. Standard specification: MSS SP-80.
  - b. Connections: with hex. shoulders.
  - c. Body: Y-pattern with integral seat at 45°, screw-in cap with hex head.
  - d. Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
2. NPS 2½ and over, cast iron:
  - a. Body and bolted cover: with tapped and plugged opening on each side for hinge pin.
    - .1 Up to NPS 16: cast iron to ASTM A126 Class B.
    - .2 NPS 18 and over: cast iron to ASTM A126 Class C.
  - b. Disc: Rotating for extended life.
    - .1 Up to NPS 6: bronze to ASTM B62.
    - .2 NPS 8 and over: bronze-faced cast iron.
  - c. Seat rings: renewable bronze to ASTM B62 screwed into body.
  - d. Hinge pin, bushings: renewable bronze to ASTM B62.

## **BALL VALVES**

1. NPS 4 and under:
  - a. Body and cap: cast high tensile bronze to ASTM B62 or brass to ASTM B16/B16M C36000.
  - b. Stem: tamperproof ball drive.
  - c. Stem packing nut: external to body.
  - d. Ball and seat: replaceable chrome plated brass solid full port ball and Teflon seats.
  - e. Stem seal: TFE with external packing nut.
  - f. Operator: removable lever handle c/w handle extension to accommodate insulation thickness.

## **CIRCUIT BALANCING VALVES (CBV)**

1. General:
  - a. Y style globe valve, designed to provide precise flow measurement and control, with valved ports for connection to differential pressure meter. Provide port extensions to allow access without removing insulation.
2. Accuracy:
  - a. Readout to be within ±2% of actual flow at design flow rate.
3. Pressure die-cast dezincification resistant copper alloy construction, Teflon disc, screw-in bonnet.

- a. Flow control: At least four 4 full turns of handwheel with digital handwheel and tamperproof concealed mechanical memory.
- 4. Insulation:
  - a. Use prefabricated shipping packaging of 5.4 R polyurethane as insulation.
- 5. Drain connection:
  - a. NPS  $\frac{3}{4}$  valved and capped, suitable for hose socket.
  - b. Incorporated into valve body or provided as separate item.
- 6. Size:
  - a. Valve to be sized for a minimum pressure drop of 6 kPa (2 ft.) at design flow at mid range. Provide pipe reducers as required.

## **LUBRICATED PLUG VALVES**

- 1. Valve:
  - a. Body: cast iron to ASTM A126 Class B semi-steel.
  - b. Plug: cylindrical or tapered, with regular Venturi or round pattern port - 90° from full open to fully closed.
  - c. Number of ports: 2.
  - d. Ends: with hexagon shoulders, ends screwed to ASME B1.20.1 up to NPS 3; Flanged to ASME B16.1 NPS 4 and over.
  - e. Lubrication system, nickel-plated.
  - f. Lubricant: to suit type, temperature, and pressure of contained fluid.
  - g. Feeding system: lubricant forced into lubrication grooves between seating surfaces of plug and body to form positive seal, leakproof operation, and corrosion preventing film. Lubricant receptacle to hold additional lubricant. Lubricant screw for lubrication. Check valve to prevent reverse flow of lubricant. O-rings between body and plug.
- 2. Operator: manual - lever.
- 3. Accessories: lubricant gun.
- 4. Testing: to ASME B16.34.

## **INSTALLATION**

- 1. Install rising stem valves in upright position with stem above horizontal.
- 2. Handwheel with chain operators are to be installed on all valves more than 3 metres above floor.
- 3. Remove internal parts before soldering or brazing.
- 4. Install all valves such that adequate clearance is provided to allow for obstruction free operation.
- 5. Install valves at all branch take-offs and to isolate each piece of equipment, and as indicated.
- 6. For all threaded valves provide one screwed union beside each valve to allow easy replacement of valve.

7. Install all valves as per manufacturer's recommendation.

## **ACCEPTABLE PRODUCTS**

1. Domestic, Heating Water up to 200 psi.

a. Ball Valve:

.1 NPS 4 & Under:

- .1 Solder: Crane 9202 ( up to 3"), Apollo 94A-200, Jenkins 202J ( up to 3"),  
Toyo 5049A, Kitz 59
- .2 Threaded: Crane 9201 (up to 4"), Apollo 94A-100, Jenkins 201J ( up to  
4"), Toyo 5044A, Victaulic 722, Kitz 58

b. Check Valve:

.1 NPS 2 & Under:

- .1 Solder: Crane 1342, Apollo 161S, Jenkins 4093J, Toyo 237, Kitz 23
- .2 Threaded: Crane 37, Apollo 161T, Jenkins 4037, Toyo 236, Kitz 22

.2 NPS 2½ & Over:

- .1 Flanged: Crane 373, Apollo 910F, Jenkins 587J, Toyo 435, Kitz 78
- .2 Grooved: Victaulic 716, Shurjoint SJT900

c. Balancing Valve:

.1 NPS 2 & Under:

- .1 Solder: Tour & Anderson STAS, Apollo 58A, Armstrong CBV-S, Bell &  
Gossett CB-S, Redwhite 9519
- .2 Threaded: Tour & Anderson STAD, Apollo 58A, Armstrong CBV-T, Bell &  
Gossett CB, Redwhite 9517

**END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCES**

1. American Society of Mechanical Engineers (ASME)
  - a. ASME B31.1, Power Piping, (SI Edition).
2. American Society for Testing and Materials (ASTM)
  - a. ASTM A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
  - b. ASTM A563/A563M, Specification for Carbon and Alloy Steel Nuts (Metric).
  - c. ASTM D1929 Standard Test Method for Determining Ignition Temperature of Plastics.
  - d. ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
  - e. ASTM E96/E96M, Standard Test Methods for Water Vapour Transmission of Materials.
3. Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
  - a. MSS SP-58, Pipe Hangers and Supports - Materials, Design, Selection, Manufacture, Application, and Installation.

## **DESIGN REQUIREMENTS**

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

## **DESIGN FOR SEISMIC EVENTS**

1. Design supports, platforms, hangers, racks to withstand seismic events as specified Section 20 05 49.01 - Seismic Restraint Systems (SRS) for Mechanical Systems.

---

## **SHOP DRAWINGS AND PRODUCT DATA**

1. Submit shop drawings and product data in accordance with Section 20 05 01 - Mechanical General Requirements (SRS) for Mechanical Systems.
2. Submit shop drawings and product data for following items:
  - a. All bases, hangers and supports.
  - b. Connections to equipment & structure.
  - c. Structural assemblies.

## **CLOSEOUT SUBMITTALS**

1. Provide maintenance data for incorporation into manual specified in Section 20 05 01 - Mechanical General Requirements.

## **GENERAL**

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

## **PIPE HANGERS**

1. Finishes:
  - a. Pipe hangers and supports: galvanized after manufacture.
  - b. Use electro-plating galvanizing process or hot dipped galvanizing process.
  - c. Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.
2. Upper attachment structural: Suspension from lower flange of I-Beam.
  - a. Cold piping NPS 2 maximums: Malleable iron C-clamp with hardened steel cup point setscrew, locknut, and carbon steel retaining clip.
    - .1 Rod: 9 mm UL listed.
  - b. Cold piping NPS 2½ or greater, all hot piping: Malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed to MSS SP-58.
3. Upper attachment structural: Suspension from upper flange of I-Beam.
  - a. Cold piping NPS 2 maximums: Ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed to MSS SP-58.
  - b. Cold piping NPS 2½ or greater, all hot piping: Malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed.
4. Manufacturer assemblies:
  - a. Sway braces for seismic restraint systems: to Section 20 05 49.01 - Seismic Restraint Systems (SRS) for Mechanical Systems.
5. Hanger rods: threaded rod material to MSS SP-58.

- a. Ensure that hanger rods are subject to tensile loading only.
- b. Provide linkages where lateral or axial movement of pipework is anticipated.
- c. Do not use 22 mm or 28 mm rod.
- 6. Pipe attachments: material to MSS SP-58.
  - a. Attachments for steel piping: carbon steel black.
  - b. Attachments for copper piping: copper plated black steel.
  - c. Use insulation shields for hot pipework.
  - d. Oversize pipe hangers and supports.
- 7. Adjustable clevis: material to MSS SP-58 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis. Ensure "U" has hole in bottom for riveting to insulation shields.
- 8. Yoke style pipe roll: carbon steel yoke, rod, and nuts with cast iron roll, to MSS SP-58.
- 9. U-bolts: carbon steel to MSS SP-58 with 2 nuts at each end to ASTM A563.
  - a. Finishes for steel pipework: black.
  - b. Finishes for copper, glass, brass, or aluminum pipework: black, with formed portion epoxy coated.
- 10. Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP-58, Type 43.
  - a. Finish: Hot dipped galvanized steel.
  - b. Acceptable material: Tolco or approved equal.

## **INSULATED PIPE SADDLES**

- 1. Insulated saddles shall be installed by the mechanical contractor when setting pipe elevation at all pipe support locations on insulated systems operating between -290°F and +250°F including:
  - a. Domestic cold water, chilled water, condenser water
  - b. Domestic hot water, heating water and low pressure steam
- 2. Composition includes:
  - a. Rigid phenolic foam insulation that meets ASTM E84 (25/50 flame spread/smoke developed requirement) with density of:
    - .1 3.75 PCF (0.17 Btu-in./hr.-ft.<sup>2</sup>-°F @ 75°F mean) for pipe sizes up to 10" IPS
  - b. Zero perm rated (ASTM E96), abuse-resistant vapour barrier jacket with 1½" wide longitudinal self-sealing acrylic tape closure system.
  - c. Pipe insulation protection shield, manufactured from carbon steel with a G90 galvanized finish, centred and adhered to bottom with a minimum of 1.5" jacketed insulation extending from each side to allow proper circumferential closure at butt joints with 3" wide zero perm tape. Shields shall be 20 gauge thick up to 3½" piping, 18 gauge for piping from 4" to 10" diameter.
  - d. Acceptable Material: Multiglass M-Saddle, Buckaroos Cooldry or approved equivalent.

---

## **INSULATION PROTECTION SHIELDS**

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

## **EQUIPMENT SUPPORTS**

1. Fabricate equipment supports not provided by equipment manufacturer from structural grade steel. Submit calculations and a stamped shop drawing for a review.

## **ROOF MOUNTED SUPPORTS**

1. Pressure treated lumber supports are only acceptable when roofed in/covered by general trades. Exposed applications are not acceptable.
2. Bases: Injection molded high density polypropylene with UV-inhibitors or recycled rubber conforming to the following:
  - a. Moisture content: Negligible.
  - b. Shrinkage/swelling due to moisture: Negligible.
  - c. Density: 894 kg/m<sup>3</sup> (55.8 lbs./ft.<sup>3</sup>).
  - d. Insect resistance: No known insect damage potential.
  - e. Chemical resistance (oil, brake fluid, gasoline, diesel, antifreeze, battery acid, sulfuric acid: no visual or physical change apparent.
  - f. Flammability: No ignition after 10 minutes, 25 kW/m, when tested in accordance with ASTM D1929.
  - g. Sized as required by loading conditions and as indicated on the drawings.
  - h. Shop fabricated with inserts for square tubing or threaded rods as required.
  - i. Colour: Integral black colour as molded.
3. Pipe Supports and Hangers: Conform to MSS SP-58 and as follows:
  - a. Fabricate of carbon steel where framing is carbon steel; fabricate of stainless steel where framing is stainless steel; finished same as framing.
  - b. Sizes 2½ in. (63 mm) and smaller: Single roller supports for piping subject to expansion and contraction; 3-sided channels and pipe clamps.
  - c. Sizes 3 in. (76 mm) and larger: Rollers, clevis hangers, or band hangers, to allow for expansion and contraction without movement of the bases or framing.
4. Accessories: Clamps, bolts, nuts, washers, and other devices as required for a complete system:
  - a. Carbon steel: Hot-dip galvanized in accordance with ASTM A153/A153M.
  - b. Stainless steel: mill finish.
5. Acceptable material: Portable Pipe Hangers (PHP), Big Foot Systems, Mifab, Miro Industries, or approved equal.

## INSTALLATION

1. Install in accordance with: manufacturer's instructions and recommendations.
2. Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
3. When attaching to open web steel joists provide additional hangers for pipes with diameters of 75 mm or greater in order to reduce the magnitude of the concentrated load and spread the load to the joists equally. In these cases the allowable spacing of hangers for pipes permitted under ASME/MSS SP-58 will be reduced and additional hangers will be required as directed by steel fabricator and/or structural engineer.
4. Locate hangers at the top of open web steel joists where the horizontal and diagonal members meet at a joint.
5. All installations must be in conjunction with Section 20 05 49.01 - Seismic Restraint System (SRS) for Mechanical Systems.

## HANGER SPACING

1. Plumbing piping: most stringent requirements of Manufacturer's recommendations, Canadian Plumbing Code, Provincial Code, or authority having jurisdiction.
2. Fire protection: to applicable fire code.
3. Gas & fuel piping: to applicable code.
4. Copper piping: up to NPS ½: every 1.5 m.
5. Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.
6. Within 300 mm of each elbow.

Maximum Pipe Size NPS	Maximum Spacing Steel	Maximum Spacing Copper	Maximum Spacing XFR
up to 1¼	2.1 m	1.8 m	1.6 m
1½	2.7 m	2.4 m	1.6 m
2	3.0 m	2.7 m	1.8 m
2½	3.6 m	3.0 m	1.8 m

7. Pipework greater than NPS 12: to MSS SP-58.

## HANGER INSTALLATION

1. Install hanger so that rod is vertical under operating conditions.
2. Adjust hangers to equalize load.
3. Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.



4. Plumbing contractor shall install insulated pipe saddles at all hanger locations. Insulated saddle jackets to be sealed, ready for integration into insulation system.

#### **HORIZONTAL MOVEMENT**

1. Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4° from vertical.
2. Where horizontal pipe movement is less than 13 mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

#### **FINAL ADJUSTMENTS**

1. Adjust hangers and supports:
  - a. Ensure that rod is vertical under operating conditions.
  - b. Equalize loads.
2. C-clamps: Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
3. Beam clamps: Hammer jaw firmly against underside of beam.

#### **END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCES**

1. Canadian General Standards Board (CGSB).
  - a. CAN/CGSB 24.3, Identification of Piping Systems.
2. Canadian Standards Association (CSA).
  - a. CSA B149.1, Natural Gas and Propane Installation Code.
  - b. CSA Z7396.1, Medical Gas Pipeline Systems - Part 1: Pipelines for Medical Gases, Medical Vacuum, Medical Support Gases, and Anaesthetic Gas Scavenging Systems.
3. National Fire Protection Association
  - a. NFPA (Fire) 13, Installation of Sprinkler Systems.

## **PRODUCT DATA**

1. Submit product data in accordance with Section 20 05 01 - Mechanical General Requirements.
2. Product data to include paint colour chips, all other products specified in this section.

## **MANUFACTURER'S EQUIPMENT NAMEPLATES**

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

## **SYSTEM NAMEPLATES**

1. Colours:
  - a. Hazardous: red letters, white background.
  - b. Elsewhere: black letters, white background.
2. Construction:
  - a. 1/8" thick laminated plastic, matte finish, with square corners, letters accurately, aligned, and machine engraved into core.
3. Sizes:
  - a. Conform to following table:

Size #	Height Sizes (mm)	No. of Lines (mm)	Height No. of Letters
1	40	1	20
2	75	1	50

b. Use maximum of 25 letters/numbers per line.

4. Locations:

- a. Terminal cabinets, control panels: Use size #1.
- b. Equipment in Mechanical Rooms: Use size #2.

## PIPING SYSTEMS GOVERNED BY CODES

1. Identification:

- a. Natural gas: To CSA B149.1.
- b. Sprinklers: To NFPA (Fire) 13.
- c. Medical Gas: To CSA Z7396.1.

## IDENTIFICATION OF PIPING SYSTEMS

1. Identify contents by background colour marking; legend; direction of flow by arrows. To CAN/CGSB-24.3 except where specified otherwise.
2. Legend:
  - a. Block capitals to sizes and colours listed in CAN/CGSB-24.3.
3. Arrows showing direction of flow:
  - a. Continuous wrap full diameter of pipe at each end of pipe identification markers.
4. Extent of background colour marking:
  - a. To full circumference of pipe or insulation.
  - b. Length to accommodate full length of legend and arrows.
5. Materials for background colour marking, legend, arrows:
  - a. Pipes and tubing  $\frac{3}{4}$ " and smaller: Waterproof and heat-resistant pressure sensitive plastic marker tags.
  - b. All other pipes: Pressure sensitive plastic-coated cloth or vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 300°F and intermittent temperature of 400°F.
6. Colours and Legends:
  - a. Where not listed, obtain direction from Engineer.
  - b. Colours for legends, arrows: To following table:

Background colour:	Legend, arrows:
Yellow	Black
Green	White
Red	White

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

Contents	Background colour marking	Legend
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
Heating glycol supply	Yellow	HEATING GLYCOL SUPPLY
Heating glycol return	Yellow	HEATING GLYCOL RETURN
Storm water	Green	STORM
Plumbing vent	Green	SAN. VENT
Fire protection	Red	FIRE PROT. WTR

### IDENTIFICATION DUCTWORK SYSTEMS

- 150 mm (6") high stencilled letters and directional arrows 150 mm (6") long x 50 mm (2") high.
- Colours: Black, or co-ordinated with base colour to ensure strong contrast.

### MECHANICAL EQUIPMENT, VALVES CONTROLLERS, PUMPS, BOILERS, FAN COIL, ETC.

- Lamicoid tag with 13 mm (½") stamped identification data filled with black paint.
- Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.
- Brass tags with 13 mm (½") stamped identification data filled with black paint.
- Brass tags to be stamped with system identification and valve number system as outlined below:

SYSTEM	BRASS TAG STAMP
Storm	ST-1,2, ...
Sanitary	SA-1,2, ...
Heating Water	HW-1,2, ...
Glycol Heating	GH-1,2, ...
Refrigerant	Re-1,2, ...

### CONTROLS COMPONENTS IDENTIFICATION

- Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.
- Inscriptions to include function and (where appropriate) fail-safe position.

### LANGUAGE

- Identification to be in English.

## **TIMING**

1. Provide identification only after all painting specified in Architectural section is complete re: Interior Painting has been completed.

## **INSTALLATION**

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

## **NAMEPLATES**

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

## **LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS**

1. On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at least one is visible from any one viewpoint in operating areas and walking aisles. At not more than 17 m (55 ft.) intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
2. Adjacent to each change in direction.
3. At least once in each small room through which piping, or ductwork passes.
4. On both sides of visual obstruction or where run is difficult to follow.
5. On both sides of separations such as walls, floors, partitions.
6. Where system is installed in pipe chases, ceiling spaces, galleries, other confined spaces, at entry and exit points, and at each access opening.
7. At beginning and end points of each run and at each piece of equipment in run.
8. At point immediately upstream of major manually operated or automatically controlled valves, dampers, etc. Where this is not possible, place identification as close as possible, preferably on upstream side.
9. Identification to be easily and accurately readable from usual operating areas and from access points.
10. Position of identification to be approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.
11. At branch take-offs on both main and branch.

### **MECHANICAL EQUIPMENT, VALVES, CONTROLLERS**

1. Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.
2. Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Engineer. Provide one copy (reduced in size if required) in each operating and maintenance manual.
3. Number valves in each system consecutively.
4. Where equipment is above accessible ceiling, provide coloured self-adhesive 13 mmØ dots to identify location of equipment.

**END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCES**

1. Associated Air Balance Council/Canadian Associated Air Balance Council (AABC/CAABC).
2. Government of Canada - MD 15128, Laboratory Fume Hoods.
3. National Balancing Council (NBC).

## **GENERAL**

1. TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do all other work as specified in this section.

## **QUALIFICATIONS OF TAB PERSONNEL**

1. Provide documentation confirming qualifications, successful experience.

## **PURPOSE OF TAB**

1. Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads
2. Adjust and regulate equipment and systems so as to meet specified performance requirements and to achieve specified interaction with all other related systems under all normal and emergency loads and operating conditions.
3. Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

## **EXCEPTIONS**

1. TAB of systems and equipment regulated by codes, standards to be to satisfaction of authority having jurisdiction.

## **CO-ORDINATION**

1. Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule so as to ensure completion before acceptance of project.
2. Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.
3. Coordinate TAB with controls, mechanical and electrical contractors.

---

## **PRE-TAB REVIEW**

1. Review contract documents before project construction is started and confirm in writing to Engineer adequacy of provisions for TAB and all other aspects of design and installation pertinent to success of TAB.
2. Review specified standards and report to Engineer in writing all proposed procedures which vary from standard.
3. During construction, co-ordinate location and installation of all TAB devices, equipment, accessories, measurement ports and fittings.

## **START-UP**

1. Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
2. Follow special start-up procedures specified elsewhere in Divisions 20, 21, 22, 23 & 25.

## **OPERATION OF SYSTEMS DURING TAB**

1. Operate systems for length of time required for TAB and as required by Engineer for verification of TAB reports.

## **START OF TAB**

1. Notify Engineer 10 days prior to start of TAB.
2. Start TAB only when building is essentially completed, including:
  - a. Installation of ceilings, doors, windows, other construction affecting TAB.
  - b. Application of weatherstripping, sealing, caulking.
  - c. All pressure, leakage, other tests specified elsewhere in Divisions 20, 21, 22, 23 & 25.
  - d. All provisions for TAB installed and operational.
3. Start-up, verification for proper, normal, and safe operation of all mechanical and associated electrical and control systems affecting TAB including but not limited to:
  - a. Proper thermal overload protection in place for electrical equipment.
  - b. Air systems:
    - .1 Filters in place, clean.
    - .2 Duct systems clean.
    - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
    - .4 Correct fan rotation.
    - .5 Fire, smoke, volume control dampers installed and open.
    - .6 Coil fins combed, clean.
    - .7 Access doors, installed, closed.
    - .8 All outlets installed; volume control dampers open.



- c. Liquid systems:
  - .1 Flushed, filled, vented.
  - .2 Correct pump rotation.
  - .3 Strainers in place, baskets clean.
  - .4 Isolating and balancing valves installed, open.
  - .5 Calibrated balancing valves installed, at factory settings.
  - .6 Chemical treatment systems complete, operational.
- d. Combustion air:
  - .1 With all heating appliances, within the boiler room, operating on high fire, measure:
    - .1 Combustion air volume entering boiler room from outside.
  - .2 Differential pressure to:
    - .1 Outside
    - .2 Adjacent areas of the building.
  - .3 With all heating appliances on high fire, check each natural draft appliance diverter for any back draft.

## **APPLICATION TOLERANCES**

- 1. Do TAB to following tolerances of design values:
  - a. All other HVAC systems: +5%, -5%.
  - b. Hydronic systems:  $\pm 10\%$ .

## **ACCURACY TOLERANCES**

- 1. Measured values to be accurate to within  $\pm 2\%$  of actual values.

## **INSTRUMENTS**

- 1. Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
- 2. Calibrate within 3 months of TAB.

## **SUBMITTALS**

- 1. Submit, prior to commencement of TAB:
- 2. Proposed methodology and procedures for performing TAB if different from referenced standard.

## **TAB REPORT**

- 1. Format to be in accordance with AABC/CAABC.

2. TAB report to show all results in SI units or Imperial (IP), to match drawings and specifications, and to include:
  - a. Project record drawings.
  - b. System schematics.
3. Submit pdf electronic copy of TAB Report to Engineer for verification and approval.

## **VERIFICATION**

1. All reported results subject to verification by Engineer.
2. Provide manpower and instrumentation to verify up to 30% of all reported results.
3. Number and location of verified results to be at discretion of Engineer.
4. Bear costs to repeat TAB as required to satisfaction of Engineer.
5. At request of commissioning agent, provide manpower and instrumentation to verify an additional 30% of all reported results.
6. At the request of the Engineer, provide manpower and instrumentation to adjust airflows & rooftop units to revised air values as a result of noise issue or other commissioning problems.

## **SETTINGS**

1. After TAB is completed to satisfaction of Engineer, replace drive guards, close all access doors, lock all devices in set positions and ensure sensors are at required settings.
2. Permanently mark all settings to allow restoration at any time during life of facility. Markings not to be eradicated or covered in any way.

## **COMPLETION OF TAB**

1. TAB to be considered complete only when final TAB Report received and approved by Engineer.

## **SYSTEMS**

1. Quality assurance: Perform TAB of complete mechanical systems over entire operating range in accordance with most stringent conditions of AABC/CAABC & NBC.
2. Air Systems: Include both specified and measured data.
  - a. Air Handling Equipment:
    - .1 Maximum air flow volume.
    - .2 Fan total pressure.
    - .3 Motor volts, amps, and power.
    - .4 Minimum outside air volume.
  - b. Duct Air Quantities - Mains and Branches:
    - .1 Duct size.
    - .2 Number of pressure/velocity readings per traverse.

- 
- .3 Sum of velocity measurements.
  - .4 Average velocity.
  - .5 Duct air flow volume.
  - .6 Barometric pressure and duct air temperature.
  - c. Air Outlets:
    - .1 Outlet location and designation.
    - .2 Manufacturers catalogue identification and type.
    - .3 Air outlet flow factors. Use 1.0 when flow hood is used.
    - .4 Air flow volumes.
    - .5 Deflector vane or diffuser cone settings.
  - 3. Hydronic Systems: Include both specified and measured data.
    - a. Pumps:
      - .1 Discharge and suction pressures, at design flow and no flow.
      - .2 Fluid flow rate. Calculate from pump curves if metering not provided.
      - .3 Motor volts, amps, power.
      - .4 RPM.
    - b. Piping Systems:
      - .1 Supply and return of each primary loop.
      - .2 Supply and return of each secondary loop.
      - .3 Make-up water inlet.
      - .4 Domestic hot water recirculation.
    - c. Heating Equipment:
      - .1 Equipment type, location, and designation.
      - .2 Fluid used. Identify fluid used; water, % water/ethylene glycol mixes, steam, etc.
      - .3 Fluid flow rate.
      - .4 Fluid entering and leaving temperatures and pressures
    - d. Air Heating and Cooling Coils:
      - .1 Coil type and identification, location, and designation.
      - .2 Entering and leaving air dry and wet bulb temperatures.
      - .3 Air flow volume.
      - .4 Fluid flow rate.
      - .5 Fluid entering and leaving temperatures and pressures.
    - e. Unit and Cabinet Heater:
      - .1 Start unit and check for noise or vibration.

- .2 Check unit performance for each fan speed:
  - .1 Air flow and temperature rise.

## **PLUMBING SYSTEMS**

1. Inlet and outlet temperature of each heater or tank.
2. Main supply piping main branch piping.
3. Flush valves adjusted to suit project pressure conditions.

## **OTHER SYSTEMS**

1. Plumbing systems:
  - a. Controlled flow roof drain systems: adjust weirs to suit actual roof conditions, slopes, areas drained.
2. Building pressure conditions:
  - a. Adjust HVAC systems, equipment, controls to ensure specified pressure conditions at all times.
3. Zone pressure differences:
  - a. Adjust HVAC systems, equipment, controls to establish specified air pressure differentials, with all systems in all possible combinations of normal operating modes.

## **BALANCING AND ADJUSTING PREPARATION**

1. Perform testing, adjusting and balancing work after equipment and systems starting procedures have been properly completed.
2. Perform balancing during heating and cooling season of first year of operation, and at times when directed by Engineer, to ensure proper settings of controls under both summer and winter peak load conditions.
3. Vary load to verify operation of system under partial load conditions. Test start-up, shut-down, emergency conditions, safety controls operation and automatic and manual resets and interlocks.
4. Cap all instrument test ports. Obtain caps from sheet metal contractor and install.
5. For all adjustable diffusers/grilles: Adjust air pattern to ensure proper air distribution and to avoid dumping. Air velocity shall not exceed 0.25 m/s (50 fpm) in the occupied zone (or as directed by Engineer).
6. Allow for ultrasonic flow measurement where hydronic flow measurements are required, but circuit balancing valves are not provided.

## **END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCES**

1. American Society for Testing and Materials (ASTM).
  - a. ASTM B209/B209M, Specification for Aluminum and Aluminum Alloy Sheet and Plate.
  - b. ASTM C335/C335M, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
  - c. ASTM C449, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
  - d. ASTM C921, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
2. Canadian General Standards Board (CGSB)
  - a. CAN/CGSB-51.10, Mineral Fibre Board Thermal Insulation.
  - b. CAN/CGSB 51.11, Mineral Fibre Thermal Insulation Blanket.
  - c. CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
3. Manufacturer's Trade Associations: Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
4. Underwriters Laboratories (UL)
  - a. UL 723, Tests for Surface Burning Characteristics of Building Materials.
5. Underwriters Laboratories of Canada (ULC)
  - a. CAN-ULC-S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

## **DEFINITIONS**

1. For purposes of this section:
  - a. "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
  - b. "EXPOSED" - will mean "not concealed" as defined herein.
  - c. Insulation systems - insulation material, fasteners, jackets, and other accessories.
2. TIAC Codes:
  - a. CRD: Code Round Ductwork,
  - b. CRF: Code Rectangular Finish.

---

## **SHOP DRAWINGS**

1. Submit shop drawings in accordance with Section 20 05 01 - Mechanical General Requirements.
2. Submit for approval manufacturer's catalogue literature related to installation, fabrication for duct jointing recommendations.

## **QUALIFICATIONS**

1. Installer to be specialist in performing work of this section and have at least 5 years' successful experience in this size and type of project, qualified to standards.

## **DELIVERY, STORAGE AND HANDLING**

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

## **FIRE AND SMOKE RATING**

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

## **INSULATION**

1. Mineral fibre as specified herein includes glass fibre, rock wool, slag wool.
2. Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C335/C335M.
3. TIAC Code C-1: Rigid mineral fibre board to CAN/CGSB-51.10, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).
4. TIAC Code C-2: Mineral fibre blanket to CAN/CGSB-51.11 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
  - a. Mineral fibre: to CAN/CGSB-51.11.
  - b. Jacket: to CGSB 51-GP-52Ma.
  - c. Maximum "k" factor: to CAN/CGSB-51.11.
  - d. Density: 24 kg/m<sup>3</sup>.

## **JACKETS**

1. Canvas: 220 gm/m<sup>2</sup> cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
2. Lagging adhesive: Compatible with insulation.

3. Acrylic Adhesive (Indoor Applications only):
  - a. Thickness: 0.18 mm.
  - b. Finish: Stucco embossed.
  - c. Peel Adhesion: 18N/25 mm (65 oz./in.)
  - d. Puncture: 130N (30 lbs.).
  - e. UL 723 listed (10/20 flame/smoke rating).
  - f. Acceptable material: VentureClad 1577CW.

## **ACCESSORIES**

1. Vapour retarder lap adhesive: Water based, fire retardant type, compatible with insulation.
2. Indoor Vapour Retarder Finish: Vinyl emulsion type acrylic, compatible with insulation.
3. Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.
4. Tape: self-adhesive, aluminum, reinforced, 75 mm (3") wide minimum.
5. Contact adhesive: quick-setting
6. Canvas adhesive: washable.
7. Tie wire: 1.5 mm stainless steel.
8. Banding: 19 mm (¾") wide, 0.5 mm thick stainless steel.
9. Facing: 25 mm (1") galvanized steel hexagonal wire mesh stitched on one face of insulation.
10. Fasteners: 2 mm diameter pins with 38 mm (1½") diameter clips, length to suit thickness of insulation.

## **PRE- INSTALLATION REQUIREMENTS**

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

## **INSTALLATION**

1. Install in accordance with TIAC National Standards.
2. Apply materials in accordance with manufacturers instructions and this specification.
3. Use two layers with staggered joints when required nominal thickness exceeds 75 mm (3").
4. Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - a. Hangers, supports to be outside vapour retarder jacket.
5. Supports, Hangers in accordance with Section 23 05 29 - Bases, Hangers and Supports
  - a. Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
6. Fasteners: At 300 mm (12") oc in horizontal and vertical directions, minimum two rows each side.

## DUCTWORK INSULATION SCHEDULE

1. Insulation types and thicknesses: Conform to following table:

	<b>TIAC Code</b>	<b>Vapour Retarder</b>	<b>Thickness mm (in.)</b>
Rectangular cold and dual temperature supply & return air ducts in exposed areas including silencers (mechanical room, open ceiling, etc.)	C-1	yes	25 (1")
Cold and dual temperature supply air ducts in concealed ceiling space and all round cold ducts including silencers	C-2	yes	25 (1")
Exhaust ducts within 3 m from roof/ exterior wall penetration	C-1	yes	50 (2")
Acoustically lined ductwork inside building	none		

2. Exposed round ducts 600 mm and larger, smaller sizes where subject to abuse:
  - a. Use TIAC code C-1 insulation, scored to suit diameter of duct.
3. Finishes: Provide aluminum jacket on ductwork within transition curbs.

**END OF SECTION**



## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCES**

1. American Society for Testing and Materials (ASTM) (latest edition).
  - a. ASTM B209/B209M, Specification for Aluminum and Aluminum Alloy Sheet and Plate.
  - b. ASTM C335/C335M, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
  - c. ASTM C449, Standard Specification for Mineral Fibre -Hydraulic-Setting Thermal Insulating and Finishing Cement.
  - d. ASTM C921, Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
2. Canadian General Standards Board (CGSB)
  - a. CAN/CGSB-51.2, Thermal Insulation, Calcium Silicate, for Piping, Machinery and Boilers.
  - b. CAN/CGSB 51.9, Mineral Fibre Thermal Insulation for Piping and Round Ducting.
  - c. CAN/CGSB 51.11 , Mineral Fibre Thermal Insulation Blanket.
  - d. CAN/CGSB-51.12, Cement, Thermal Insulating and Finishing.
  - e. CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
3. Manufacturer's Trade Associations (latest edition).
  - a. Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
4. Underwriters' Laboratories of Canada (ULC)
  - a. CAN-ULC S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

## **DEFINITIONS**

1. For purposes of this section:
  - a. "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
  - b. "EXPOSED" - will mean "not concealed" as defined herein.
2. TIAC Codes:
  - a. CPF: Code Piping Finish.

---

## **SHOP DRAWINGS**

1. Submit shop drawings in accordance with Section 20 05 01 - Mechanical General Requirements.
2. Submit for approval manufacturer's catalogue literature related to installation, fabrication for pipe, fittings, valves, and jointing recommendations.

## **MANUFACTURER'S INSTRUCTIONS**

1. Submit manufacturer's installation instructions in accordance with Section 20 05 01 - Mechanical General Requirements.
2. Installation instructions to include procedures to be used, installation standards to be achieved.

## **QUALIFICATIONS**

1. Installer to be specialist in performing work of this section and have at least 5 years' successful experience in this size and type of project, qualified to standards.

## **DELIVERY, STORAGE AND HANDLING**

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

## **FIRE AND SMOKE RATING**

1. In accordance with ULC S102:
  - a. Maximum flame spread rating: 25.
  - b. Maximum smoke developed rating: 50.

## **INSULATION**

1. Mineral fibre as specified herein includes glass fibre, rock wool, slag wool.
2. Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C335/C335M.
3. TIAC Code A-3: Rigid moulded mineral fibre with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
  - a. Mineral fibre: to CAN/CGSB-51.9.
  - b. Jacket: to CGSB 51-GP-52Ma.
  - c. Maximum "k" factor: to CAN/CGSB-51.9.
4. TIAC Code C-2: Mineral fibre blanket faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
  - a. Mineral fibre: to CAN/CGSB-51.11.

- b. Jacket: to CGSB 51-GP-52Ma.
  - c. Maximum "k" factor: to CAN/CGSB-51.11.
  - d. Density: 24 kg/m<sup>3</sup>.
- 5. TIAC Code A-6: vapour retarder flexible unicellular tubular elastomer.
  - a. Jacket: to CGSB 51-GP-52
  - b. Maximum "k" factor.
  - c. Certified by manufacturer free of potential stress corrosion cracking corrodents.
- 6. TIAC Code A-2: Rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.
  - a. Insulation: to CAN/CGSB-51.2.
  - b. Maximum "k" factor: to CAN/CGSB-51.2.
  - c. Design to permit periodic removal and re-installation.

#### **INSULATION SECUREMENT**

- 1. Tape: Self-adhesive, aluminum, reinforced, 50 mm wide minimum.
- 2. Contact adhesive: Quick setting.
- 3. Canvas adhesive: Washable.
- 4. Tie wire: 1.5 mm diameter stainless steel.
- 5. Bands: Stainless steel, 19 mm wide, 0.5 mm thick.

#### **CEMENT**

- 1. Thermal insulating and finishing cement:
  - a. To CAN/CGSB-51.12.
  - b. Hydraulic setting or Air drying on mineral wool, to ASTM C449.

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

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

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

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

#### **JACKETS**

- 1. Canvas:
  - a. 220 gm/m<sup>2</sup> cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
  - b. Lagging adhesive: Compatible with insulation.

- c. Random samples to be taken during installation c/w date & time on sample.
- 2. Aluminum:
  - a. To ASTM B209.
  - b. Thickness: 0.50 mm sheet.
  - c. Finish: embossed.
  - d. Joining: Longitudinal and circumferential slip joints with 50 mm laps.
  - e. Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
  - f. Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.
- 3. PVC:
  - a. Ontario Building Code compliant for 25/50 flame spread and smoke developed.
  - b. Minimum thickness 0.38 mm.
  - c. Colour white unless otherwise specified.
  - d. Non yellowing UV stabilized.
  - e. Minimum service temperatures: -20°C.
  - f. Maximum service temperature: 65°C.
  - g. Moisture vapour transmission: 0.02 perm.
  - h. Fastenings:
    - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
    - .2 Tacks.
    - .3 Pressure sensitive vinyl tape of matching colour.

## **PRE- INSULATION REQUIREMENT**

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

## **INSTALLATION**

1. Install in accordance with TIAC National Standards.
2. Apply materials in accordance with manufacturer's instructions and this specification.
3. Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
4. All roof drain bodies shall be thermally insulated with 50 mm thick mineral fibre blanket faced with factory applied vapour retarder jacket.
5. Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - a. Hangers, supports to be outside vapour retarder jacket.

- b. Saddles to have ridges to limit movement while in hanger.
  - c. To be edge flared to prevent cutting/damage to insulation coverage.
- 6. Supports, Hangers:
  - a. Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulated saddles have not been provided.
  - b. Butt insulation up to insulated saddle and seal to saddle jacket as per TIAC code requirement.

**INSTALLATION OF ELASTOMERIC INSULATION**

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

**PIPING INSULATION SCHEDULES**

- 1. Includes low loss headers, valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- 2. TIAC Code: A-3.
  - a. Securements: Tape at 300 mm oc.
  - b. Seals: VR lap seal adhesive, VR lagging adhesive.
  - c. Installation: TIAC Code: 1501-C.
- 3. TIAC Code: A-6.
  - a. Insulation securements: Bands.
  - b. Seals: lap seal adhesive, lagging adhesive.
- 4. TIAC Code: C-2.
  - a. Insulation securements: combination of wire and bands.
  - b. Seals: lap seal adhesive, lagging adhesive.
  - c. Installation: TIAC Code: 1501-C.
- 5. TIAC Code: A-2.
  - a. Insulation securements: stainless steel bands.
  - b. Seals: lap seal adhesive, lagging adhesive.
  - c. Installation: TIAC Code: 1501-H.
- 6. Thickness of insulation to be as listed in following table:

Application	Temp °C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)	
			½ to 1¼	1½ to 3

---

Hot Water Heating	61 - 93	A-3	38	50
Glycol Heating	61 - 93	A-3	40	50
Storm Piping		A-3	25	25
Storm Roof Drains		C-2	50	50

7. Finishes:

- a. Piping & fittings: PVC.
  - b. Exposed exterior: Aluminum.
  - c. Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.
  - d. Finish attachments: Stainless steel bands at 150 mm oc. Seals: wing or closed.
  - e. Installation: To appropriate TIAC code CPF/1 through CPF/5.
8. Storm piping & fittings to be insulated from all roof drain bodies to storm piping at grade level.
9. Domestic hot & cold and recirc piping shall be completely thermally insulated to fixtures, except exposed supply assembly at fixtures.

**END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS**

1. In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

## **HYDRONIC SYSTEMS PERFORMANCE VERIFICATION**

1. After cleaning is completed and system is in full operation.
2. When systems are operational, perform following tests:
  - a. Conduct full scale tests at maximum design flow rates, temperatures, and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.
  - b. Verify performance of hydronic system circulating pumps as specified in relevant technical sections, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.
    - .1 Pump operation.
    - .2 Heat exchanger operation.
    - .3 Pressure bypass open/closed.
    - .4 Control pressure failure.
    - .5 Maximum heating demand.
    - .6 Maximum cooling demand.
    - .7 Outdoor reset. Re-check heat exchanger output supply temperature at 100% and 50% reset, maximum water temperature.

## **GLYCOL SYSTEMS**

1. Test to prove concentration will prevent freezing to -40°C Test inhibitor strength and include in procedural report. Refer to ASTM E 202.

## **SANITARY AND STORM DRAINAGE SYSTEMS**

1. Buried systems: Perform CCTV camera inspection tests prior to back-filling. Perform hydraulic tests to verify grades and freedom from obstructions.
2. Ensure that traps are fully and permanently primed.
3. Ensure that fixtures are properly anchored, connected to system.
4. Operate flush valves, tank, and operate each fixture to verify drainage and no leakage.
5. Cleanouts: Refer to Section 22 42 01 - Plumbing Specialties and Accessories.

6. Roof drains:

- a. Refer to Section 22 42 01 - Plumbing Specialties and Accessories.
- b. Remove caps as required.

**END OF SECTION**



## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **CLEANING SOLUTIONS**

1. Tri-sodium phosphate: 0.40 kg per 100 L water in system.
2. Sodium carbonate: 0.40 kg per 100 L water in system.
3. Low-foaming detergent: 0.01 kg per 100 L water in system.

## **GENERAL**

1. Provide all material & labour associated with flushing and cleaning of system including full size bypass and associated accessories.

## **CLEANING HYDRONIC AND STEAM SYSTEMS**

1. Timing: Systems to be operational, hydrostatically tested and with safety devices functional before cleaning is carried out.
2. Cleaning Agency: Retain qualified water treatment specialist to perform system cleaning.
3. Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.
4. Cleaning procedures:
  - a. Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:
    - .1 Cleaning procedures, flow rates, elapsed time.
    - .2 Chemicals and concentrations to be used.
    - .3 Inhibitors and concentrations.
    - .4 Specific requirements for completion of work.
    - .5 Special precautions for protecting piping system materials and components.
    - .6 Complete analysis of water to be used to ensure water will not damage systems or equipment.
5. Conditions at time of cleaning of systems
  - a. Systems to be free from construction debris, dirt, and other foreign material.
  - b. Control valves to be operational, fully open to ensure that terminal units can be cleaned properly.
  - c. Strainers to be clean prior to initial fill.
  - d. Install temporary filters on pumps not equipped with permanent filters.

- e. Install pressure gauges on strainers to detect plugging.
- 6. Report on Completion of Cleaning. When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.
- 7. Hydronic Systems:
  - a. Fill system with water, ensure air is vented from system.
  - b. Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).
  - c. Use water meter to record volume of water in system to  $\pm 0.5\%$ .
  - d. Add chemicals under direct supervision of chemical treatment supplier.
  - e. Closed loop systems: circulate system cleaner at 60°C for at least 36 h. Drain as quickly as possible. Refill with water plus inhibitors. Test concentrations and adjust to recommended levels.
  - f. Flush velocity in system mains and branches to be adequate so as to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.
  - g. Add chemical solution to system.
  - h. Establish circulation, raise temperature slowly to maximum design or 82°C minimum. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38°C. Drain as quickly as possible. Refill with clean water. Circulate for 6 h at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).

## **START-UP OF HYDRONIC SYSTEMS**

- 1. After cleaning is completed and system is filled:
  - a. Establish circulation and expansion tank level, set pressure controls.
  - b. Ensure all air is removed.
  - c. Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.
  - d. Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.
  - e. Clean out strainers repeatedly until system is clean.
  - f. Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and all other noises.
  - g. Bring system up to design temperature and pressure slowly over a 24 hour period.
  - h. Perform TAB as specified Section 23 05 93 - Testing, Adjusting and Balancing (TAB).
  - i. Adjust pipe supports, hangers, springs, as necessary.
  - j. Monitor pipe movement, performance of expansion joints, loops, guides, anchors.

- 
- k. If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.
  - l. Re-tighten all bolts, etc. using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
  - m. Check operation of drain valves.
  - n. Adjust valve stem packings as systems settle down.
  - o. Fully open all balancing valves (except those that are factory-set).
  - p. Check operation of over-temperature protection devices on circulating pumps.
  - q. Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

**END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCE STANDARDS**

1. American National Standards Institute/American Water Works Association (ANSI/AWWA):
  - a. ANSI/AWWA C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
2. American Society of Mechanical Engineers (ASME):
  - a. ASME B16.3, Malleable Iron Threaded Fittings: Classes 150 and 300
  - b. ASME B16.5, Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard
  - c. ASME B16.9, Factory-Made Wrought Buttwelding Fittings
3. ASTM International (ASTM):
  - a. ASTM B16/B16M, Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines
  - b. ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless
  - c. ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings
4. CSA Group (CSA):
5. CSA Group (CSA):
  - a. CSA W48, Filler Metals and Allied Materials for Metal Arc Welding
6. Manufacturer's Standardization of the Valve and Fittings Industry (MSS):
  - a. MSS-SP-67, Butterfly Valves
  - b. MSS-SP-71, Grey Iron Swing Check Valves Flanged and Threaded Ends

## **ACTION AND INFORMATIONAL SUBMITTALS**

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

## **CLOSEOUT SUBMITTALS**

1. Submit in accordance with Section 01 78 00 - Closeout Submittals.

2. Operation and Maintenance Data: submit operation and maintenance data for hydronic systems for incorporation into manual.
  - a. Include special servicing requirements.

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

1. Deliver, store, and handle materials in accordance with Section 01 61 00 - Common Product Requirements.

## **PIPE**

1. Steel pipe: to ASTM A53/A53M, Grade B, as follows:
  - a. To NPS 6: Schedule 40.

## **PIPE JOINTS**

1. NPS 2 and under: screwed fittings with PTFE tape or lead-free pipe dope.
2. NPS 2-1/2 and over: welding fittings and flanges to CSA W48.
3. Orifice flanges: slip-on raised face, 2100 kPa.
4. Flange gaskets: to ANSI/AWWA C111/ A21.11.
5. Pipe thread: taper.

## **FITTINGS**

1. Screwed fittings: malleable iron, to ASME B16.3, Class 150.
2. Pipe flanges and flanged fittings:
  - a. Steel: to ASME B16.5
3. Butt-welding fittings: steel, to ASME B16.9

## **VALVES**

1. Connections:
  - a. NPS 2 and smaller: screwed ends.
  - b. NPS 2-1/2 and larger: flanged ends.
2. Ball Valves:
  - a. NPS 2 and under: cast high tensile bronze to ASTM B62 or brass to ASTM B16/B16M, tamper proof stem with TFE seal, chrome plated brass solid full port ball, Teflon seats.
3. Butterfly valves: to MSS-SP-67:
  - a. NPS 2-1/2 and over: lug type
4. Balancing, for TAB:
  - a. Sizes: calibrated balancing valves, as specified this section.

- b. NPS 2 and under:
  - .1 Mechanical Rooms: Ball valve.
  - .2 Elsewhere: Ball valve.
- 5. Drain valves: Ball valve.
- 6. Swing check valves: to MSS-SP-71.
  - a. NPS 2 and under:
    - .1 Class 125, swing, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.
  - b. NPS 2-1/2 and over:
    - .1 Flanged ends: as specified Section 23 05 23.02 - Valves - Cast Iron.

#### **CIRCUIT BALANCING VALVES**

- 1. Install flow measuring stations and flow balancing valves as indicated.
- 2. Remove handwheel after installation and when TAB is complete.
- 3. Tape joints in prefabricated insulation on valves installed in chilled water mains.

#### **CLEANING, FLUSHING AND START-UP**

- 1. In accordance with Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems.

#### **BALANCING**

- 1. Balance water systems to within plus or minus 5% of design output.

#### **PROTECTION**

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

#### **END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCES**

1. American Society of Mechanical Engineers (ASME).
  - a. ASME BPVC.VIII.1, ASME Boiler and Pressure Vessel Code Section VIII, Division 1 - Rules for Construction of Pressure Vessels.

## **PRODUCT DATA**

1. Submit product data in accordance with Section 20 05 01 - Mechanical General Requirements.

## **SHOP DRAWINGS**

1. Submit shop drawings in accordance with Section 20 05 01 - Mechanical General Requirements.

## **CLOSEOUT SUBMITTALS**

1. Submit maintenance data in accordance with Section 20 05 01 - Mechanical General Requirements.

## **EXPANSION TANKS**

1. Horizontal or vertical steel pressurized removable bladder type expansion tank as per schedule.
2. Bladder in EPDM suitable for 115°C (240°F) operating temperature (water and glycol).
3. Working pressure: 862 kPa (125 psi) with ASME stamp and certification including Canadian Registration Number (CRN).
4. Air pre-charged to initial fill pressure of system as per schedule.
5. Saddles for horizontal installation Base mount for vertical installation.
6. Supports: Provide supports with hold down bolts and installation templates incorporating seismic restraint systems.
7. Capacity: as per schedule.
8. Acceptable materials: Amtrol.

## **AUTOMATIC AIR VENT**

1. System vents (hot water, glycol & chilled water):
  - a. Industrial float vent: cast iron body and NPS ¾ connection and rated at 1034 kPa working pressure.
  - b. Float: solid material suitable for 115°C working temperature.

- c. Acceptable materials: Spirax/Sarco Model 13WS.
- 2. Coil Vents (all equipment headers & high points in system):
  - a. Industrial float vent: brass alloy body and NPS ½ connection and rated at 1034 kPa working pressure.
  - b. Float: stainless steel with viton rubber valve seal suitable for 115°C working temperature.
  - c. Acceptable materials: Spirax/Sarco Model AE30.

## **PIPELINE STRAINER**

- 1. NPS ½ to 2: threaded connections:
  - a. Wye-pattern, lead-free cast iron body.
  - b. Screen: 304 stainless steel #20 mesh.
  - c. Maximum working pressure: 2.75 MPa (400 psi) at 66°C (15°F) and 1.70 MPa (250 psi) at 208°C (406°F).
  - d. Tapped retainer cap.
- 2. NPS 2½ to 12: class 125, flanged connections:
  - a. Wye-pattern, lead-free cast iron body.
  - b. Screen: stainless steel with perforations between 5 mm and 6 mm.
  - c. Maximum working pressure: 1.4 MPa (200 psi) at 99°C (210°F) and 0.85 MPa (125 psi) at 178°C (353°F).
  - d. Cast iron flange retainer cap with gasket tapped for closure plug.
  - e. Drain/blow-off connection furnished with closure plug.
- 3. Acceptable material: Crane, Watts, Victaulic, Kitz, Jenkins, Toyo, Conbraco.

## **PLATE AND FRAME HEAT EXCHANGER**

- 1. Counter flow plate heat exchanger with front end connections.
- 2. Construction:
  - a. Plates: 304 stainless steel.
  - b. Gaskets: EPDM
  - c. Frame: carbon steel
  - d. Connections: threaded NPT SS316L
- 3. Maximum working pressure: 45 bar (650 PSI).
- 4. Maximum working temperature: 230°C (445°F).
- 5. Acceptable manufacturers: AIC



---

### **GLYCOL MAKE-UP PACKAGE (GMU)**

1. The contractor shall supply and install, as indicated on the plans and in the specifications, a prefabricated, automatic, and autonomous make-up package for the glycol system.
2. The package shall be wall mounted to operate on a standard 120 V, 15 Amp, 60 Hz electrical circuit, and to maintain a fill pressure in the glycol systems as indicated.
3. Digital pressure display, visual alarm on low level with remote dry contacts. Digital pressure switch adjustable from 0 kPa to 310 kPa (0-45 psig).
4. Low level alarm panel provides a selectable audible alarm and remote monitoring dry contacts.
5. A translucent 64L (17 USgal) polyethylene solution container, complete with lid, shall be mounted on the pumping assembly and shall include a strainer and a shut off valve. Built-in glycol solution recovery line shall be piped in from the system relief valve outlet to the solution container.
6. The assembly shall be floor mounted. It shall include a 0.04 L/s (0.7 USGPM) at free flow pump, 120 V to 24 VDC 50W AC motor, a magnetic starter, a pressure tank with a pressure control, a priming valve, a PRV, a shut-off valve and a pressure gauge. It shall be connected to the system with a 13 mm (1/2") NPT connection.
7. Acceptable material: Axiom DMF 200 & RIA10-1-SAA low level alarm panel & remote contacts.

### **PROPYLENE GLYCOL**

1. Provide pre-mixed propylene glycol in 50% concentration by weight for glycol heating system. Acceptable material: Dowfrost or equal.

### **GENERAL**

1. Install as indicated and to manufacturer's recommendations.
2. Run drain lines and blow off connections to terminate above nearest drain.
3. Maintain proper clearance to permit service and maintenance.
4. Should deviations beyond allowable clearances arise, request, and follow Engineer's directive.
5. Check shop drawings for conformance of all tapings for ancillaries and for equipment operating weights.
6. During filling of hydronic systems or equipment, vent systems & equipment properly to remove air prior to opening equipment piping to overall system. Air propagating to system, will be the responsibility of contractor to remove.

### **STRAINERS**

1. Install in horizontal or down flow lines.
2. Ensure clearance for removal of basket.
3. Install ahead of each pump.
4. Install ahead of each automatic control valve larger than NPS 1 and radiation except at radiation and as indicated.

### **AUTOMATIC AIR VENTS**

1. Install automatic air vents at high points of piping systems.
2. Install full port ball at each automatic air vent.
3. Air vents must have minimum connection of 13 mm ( $\frac{1}{2}$ ").

### **EXPANSION TANKS**

1. Adjust expansion tank pressure to suit design criteria.
2. Provide isolation valve on water inlet and drain valve between isolation valve and tank.
3. Install tee connection at air inlet to tank c/w pressure gauge and isolation valves for pressure gauge and fill connection.
4. Charge tank with nitrogen to required minimum operating pressure.

### **PRESSURE SAFETY RELIEF VALVES**

1. Water run discharge pipe to terminate above nearest drain.
2. Glycol run discharge pipe to terminate at glycol tank.

**END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCES**

1. Canadian Standards Association (CSA).
2. Hydraulic Institute Standards.
3. Underwriters Laboratories (UL)
  - a. UL 778, Motor Operated Water Pumps.

## **SHOP DRAWINGS AND PRODUCT DATA**

1. Submit shop drawings and product data in accordance with Section 20 05 01 - Mechanical General Requirements.
2. Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories, and controllers.
3. Submit product data of pump curves for review showing points of operation.
4. Indicate piping, valves and fittings shipped loose by packaged equipment supplier, showing their final location in field assembly.

## **CLOSEOUT SUBMITTALS**

1. Provide maintenance data for incorporation into manual specified in Section 20 05 01 - Mechanical General Requirements.

## **VERTICAL IN-LINE MULTI-STAGE CENTRIFUGAL PUMP**

1. Materials of Construction:
  - a. Suction/discharge base, pump head, motor stool: Cast iron, A-48-30 B
  - b. Shaft: Stainless Steel, AISI 316 or 431.
  - c. Impellers, diffuser chambers, outer sleeve: Stainless steel, AISI 304
  - d. Impeller wear rings: Stainless steel, AISI 304
  - e. Shaft journals and chamber bearings: Silicon carbide.
  - f. O-rings: EPDM or FKM.
2. Impeller:
  - a. Enclosed type with resistance spot-welded curved profiled blades and shall be secured directly to the pump shaft by means of a splined shaft arrangement.

3. Shaft seal design cartridge type design. Seal replacement shall be possible without removal of any pump components other than the coupling guard, shaft coupling and motor.
4. Motor:
  - a. C or D-faced directly coupled to the pump.
  - b. Designed for continuous duty operation, NEMA design A or B with a service factor rating no less than 1.15.
  - c. Totally Enclosed Fan Cooled Motors are to be furnished with class "F" insulation.
  - d. End bearings shall be adequately sized so that the minimum L10 bearing life is 17,500 hours at the minimum allowable continuous flow rate for the pump at full rated speed.
5. Integrated Variable Frequency Drive (VFD):
  - a. Integrated Variable Frequency Drive design consists of a VFD with a built-in pump system controller. The complete assembly shall be built and tested as one unit by the same manufacturer.
  - b. VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of the motor. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump control and to eliminate the need for motor de-rating.
  - c. RFI filter (Radio Frequency Interference) to minimize electrical noise disturbances between the power electronics and the power supply. The VFD/motor shall meet all requirements of the EMC directive concerning residential and light industry equipment (EN 61800-3)
  - d. Minimum of two skip frequency bands which can be field adjustable
  - e. Internal solid-state overload protection designed to trip within the range of 125-150% of rated current.
  - f. Protection against input transients, loss of AC line phase, over voltage, under-voltage, VFD over-temperature, and motor over-temperature.
  - g. Automatic De-Rate Function: During periods of overload allowing for reduced capacity pump operation without complete shut-down of the system. Detection of overload shall be based on continuous monitoring of current, voltage and temperature within the VFD/motor assembly.
6. Pump System Controller:
  - a. VFD/motor shall be capable of receiving a remote analog set-point (4-20mA or 0-10 VDC) as well as a remote on/off (digital) signal.
  - b. Pump status and alarm state shall be indicated via two LED lights located on the VFD/motor enclosure.
  - c. Advanced programming and troubleshooting shall be possible via a field connected personal computer.
  - d. Capable of communicating using BACnet.
7. Capacity: Refer to Schedule on drawing.

8. Acceptable material: Grundfos

## **INSTALLATION**

1. In line circulators: install as indicated by flow arrows. Support at inlet and outlet flanges or unions. Install with bearing lubrication points accessible. Install motor in orientation as recommended by manufacturer.
2. Allow for on site alignment and certification of base mounted end suction pumps by manufacturer's representative.
3. Ensure that pump body does not support piping or equipment. Provide stanchions or hangers for this purpose. Refer to manufacturer's installation instructions for details.
4. Pipe drain tapping to nearest floor drain c/w full port ball valve.
5. Install volute venting pet cock in accessible location.
6. Check rotation prior to start-up.
7. Install ball valves on pump suction & discharge tap-ins for pressure gauge.
8. All pumps to be installed in accordance with Hydraulic Institute Standards.
9. Provide flexible connectors on suction and discharge of all pumps with exception of in-line circulators.
10. On vertical in-line pumps, where specified, replace flush line filter following commissioning & startup.

## **START-UP**

1. General
  - a. In accordance with Section 25 01 11 - Commissioning - Mechanical Systems; supplemented as specified herein.
2. Procedures:
  - a. Before starting pump, check that cooling water system, over-temperature and other protective devices are installed and operative.
  - b. Provide on site alignment and certification by manufacturer's representative of base mounted end suction pumps.
  - c. After starting pump, check for proper, safe operation.
  - d. Check installation, operation of mechanical seals. Adjust, as necessary.
  - e. Check base for free-floating, no obstructions under base.
  - f. Run-in pumps for 12 continuous hours.
  - g. Verify operation of over-temperature and other protective devices under low- and no-flow condition.
  - h. Eliminate air from scroll casing.
  - i. Adjust water flow rate through water-cooled bearings.

- j. Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.
- k. Adjust alignment of piping and conduit to ensure true flexibility at all times.
- l. Eliminate cavitation, flashing and air entrainment.
- m. Adjust pump shaft seals, stuffing boxes, glands.
- n. Measure pressure drop across strainer when clean and with flow rates as finally set.
- o. Replace seals if pump used to degrease system or if pump used for temporary heat.
- p. Verify lubricating oil levels.
- q. Remove end suction diffuser start-up strainers after one week of pump operation.

## **PERFORMANCE VERIFICATION (PV)**

- 1. General
  - a. In accordance with manufacturer's recommendations.
- 2. Exclusions:
  - a. Performance verification does not apply to small in-line circulators.
- 3. Assumptions: These PV procedures assume that:
  - a. Manufacturer's performance curves are accurate.
  - b. Valves on pump suction and discharge provide tight shut-off.
- 4. Net Positive Suction Head (NPSH):
  - a. Application: Measure NPSH for pumps which operate on open systems and with water at elevated temperatures.
  - b. Measure using procedures prescribed in the Standard.
  - c. Where procedures do not exist, discontinue PV, report to Engineer, and await instructions.
- 5. Multiple Pump Installations - Series and Parallel:
  - a. Repeat PV procedures specified above for pump performance and pump for BHP combinations of pump operations.
- 6. Mark points of design and actual performance at design conditions as finally set upon completion of TAB.
- 7. Commissioning Reports: In accordance with Section 25 01 11 - EMCS: Start-up, Verification and Commissioning., supplemented as specified herein. Reports to include:
  - a. Record of point(s) of actual performance at maximum and minimum conditions and for single and parallel operation as finally set at completion of commissioning on pump curves.
  - b. Report forms as specified Section 25 01 11 -EMCS: Start-up, Verification and Commissioning.
  - c. Pump performance curves (family of curves).

---

**END OF SECTION**

## RELATED SECTIONS

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## REFERENCES

1. American Society for Testing and Materials (ASTM)
  - a. ASTM A924/A924M, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
2. Canadian Standards Association (CSA)
  - a. CSA B228.1, Pipe, Ducts and Fittings for Residential Type Air Conditioning Systems.
3. National Fire Protection Association (NFPA)
  - a. NFPA (Fire) 90A, Installation of Air Conditioning and Ventilating Systems.
  - b. NFPA (Fire) 90B, Installation of Warm Air Heating and Air Conditioning Systems.
4. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
  - a. SMACNA 016, HVAC Air Duct Leakage Test Manual.

## SHOP DRAWINGS AND PRODUCT DATA

1. Submit shop drawings and product data in accordance with Section 20 05 01 - Mechanical General Requirements.
2. Indicate following:
  - a. Sealants
  - b. Tape
  - c. Proprietary Joints

## CERTIFICATION OF RATINGS

1. Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

## SEAL CLASSIFICATION

1. Classification as follows:

Maximum System Total Pressure Pa	SMACNA Seal Class
500	A
250	A
125	A

2. Seal classification:



- a. Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant.
- 3. Application:
  - a. All new & existing supply ductwork.
  - b. All new return & exhaust ductwork.

## **SEALANT**

- 1. Sealant: Indoor/outdoor water based duct sealant c/w UV inhibitors. Flame spread rating of 0. Smoke developed rating of 0. Temperature range of -20°F to +200°F.
  - a. Acceptable material: Carlisle Hardcast CCWI-181, or equal.

## **DUCT LEAKAGE**

- 1. In accordance with SMACNA 016.

## **FITTINGS**

- 1. Fabrication: to SMACNA.
- 2. Radiused elbows:
  - a. Rectangular: standard radius: 1.5 times width of duct.
  - b. Round: 1.5 times diameter.
- 3. Mitred elbows, rectangular:
  - a. To 400 mm (16"): with single thickness turning vanes.
  - b. Over 400 mm (16"): with double thickness turning vanes.
- 4. Branches:
  - a. Rectangular main and branch: with 45° entry on branch.
  - b. Round main and branch: enter main duct at 45° with conical connection.
  - c. Provide volume control damper in branch duct near connection to main duct.
- 5. Transitions:
  - a. Diverging: 20° maximum included angle.
  - b. Converging: 30° maximum included angle.
- 6. Offsets:
  - a. Full radiused elbows.
- 7. Obstruction deflectors: maintain full cross-sectional area. Maximum included angles: as for transitions.

## **FIRESTOPPING**

- 1. Retaining angles all around duct, on both sides of fire separation.

2. Firestopping material and installation must not distort duct.

## **GALVANIZED STEEL**

1. Lock forming quality: to ASTM A924/A924M, Z90 zinc coating.
2. Thickness, fabrication, and reinforcement: to SMACNA.
3. Joints: to SMACNA.

## **ESCUTCHEON ANGLES**

1. 40 mm x 40 mm angle iron frame on both sides of exposed rectangular or round ducts, on both sides of non-rated partitions. Escutcheon angles material & gauge shall be equal to base material.

## **HANGERS AND SUPPORTS**

1. Strap hangers: of same material as duct but next sheet metal thickness heavier than duct. Maximum size duct supported by strap hanger: 500 mm (20").
2. Hanger configuration: to SMACNA.
3. Hangers: black steel angle with black steel rods to SMACNA and following table:

<b>Duct Size (in).</b>	<b>Angle Size (in).</b>	<b>Rod Size (in).</b>
up to 30	1 x 1 x 1/8	1/4
31 to 42	1½ x 1½ x 1/8	1/4
43 to 60	1½ x 1½ x 1/8	2/5
61 to 84	2 x 2 x 1/8	2/5
85 to 96	2 x 2 x 1/5	2/5
97 and over	2 x 2 x ¼	2/5

4. Upper hanger attachments:
  - a. For concrete: manufactured concrete inserts.
  - b. For steel joist: manufactured joist clamp or steel plate washer.
  - c. For steel beams: manufactured beam clamps.

## **FLEXIBLE DUCTWORK**

1. Metallic insulated: Spiral wound flexible aluminum with triple lock mechanical joints and factory applied 25 mm (1") thick flexible glass fiber thermal insulation with vapour barrier and vinyl jacket.
2. Performance:
  - a. Factory tested to 2.5 kPa without leakage.
  - b. Maximum relative pressure drop coefficient: 3.
  - c. Maximum length: 1.5m
3. Acceptable material: Flexmaster Type T/L-T

## **GENERAL**

1. Do work in accordance with NFPA (Fire) 90A, NFPA (Fire) 90B, CSA B228.1 and SMACNA.
2. Do not break continuity of insulation vapour barrier with hangers or rods. Insulate strap hangers 100 mm (4") beyond insulated duct.
3. Support risers in accordance with ASHRAE and SMACNA.
4. Install breakaway joints in ductwork on each side of fire separation.
5. Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
6. Manufacture duct in lengths to accommodate installation of acoustic duct lining.
7. Install escutcheon sheet metal angles on both sides of exposed rectangular or round ducts on both sides of non-rated partitions. Seal void with acoustic sealant.
8. Flexible ductwork to be used for branches to diffusers where concealed.

## **HANGERS**

1. Strap hangers: install in accordance with SMACNA.
2. Angle hangers: complete with locking nuts and washers.
3. Hanger spacing: in accordance with SMACNA as follows:

<b>Duct Size mm (in.)</b>	<b>Spacing m (ft.)</b>
to 1500 (60)	3 (10)
1525 (61) and over	2.5 (8)

## **SEALING**

1. Apply sealant to outside of joint to manufacturer's recommendations.

## **LEAKAGE TESTS**

1. In accordance with SMACNA 016.
2. Do leakage tests for supply duct; maximum leakage rate 1% at 1½ times operating static pressure.
3. Make trial leakage tests as instructed to demonstrate workmanship.
4. Install no additional ductwork until trial test has been passed.
5. Test section minimum of 100 ft. long with not less than 3 branch takeoffs and two 90° elbows.
6. Complete test before insulation or concealment.

**END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCES**

1. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
2. Canadian Standards Association (CSA)
  - a. CSA B228.1, Pipes, Ducts and Fittings for Residential Type Air Conditioning.

## **PRODUCT DATA**

1. Submit product data in accordance with Section 20 05 01 - Mechanical General Requirements.
2. Indicate the following:
  - a. Flexible connections.
  - b. Duct access doors.

## **CERTIFICATION OF RATINGS**

1. Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

## **GENERAL**

1. Manufacture in accordance with CSA B228.1.

## **FLEXIBLE CONNECTIONS**

1. Frame: galvanized sheet metal frame 0.6 mm thick with fabric clenched by means of double locked seams.
2. Material:
  - a. Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at - 40°C to +90°C, density of 1.3 kg/m<sup>2</sup>.

## **ACCESS DOORS IN DUCTS**

1. Non-insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.
2. Insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.
3. Gaskets: neoprene.

4. Hardware:

- a. Up to 300 x 300 mm: 2 sash locks complete with safety chain.
- b. 301 to 450 mm: 4 sash locks complete with safety chain.
- c. Hold open devices.

**SPIN-IN COLLARS**

- 1. Conical galvanized sheet metal spin-in collars with lockable butterfly damper.
- 2. Sheet metal thickness to co-responding round duct standards.

**INSTALLATION**

1. Flexible connections:

- a. 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.
- b. Length of connection: 100 mm.
- c. Minimum distance between metal parts when system in operation: 75 mm.
- d. Install in accordance with recommendations of SMACNA.
- e. When fan is running:
  - .1 Ducting on each side of flexible connection to be in alignment.
  - .2 Ensure slack material in flexible connection.

2. Access doors and viewing panels:

- a. Size:
  - .1 450 x 450 mm for servicing entry.
  - .2 300 x 300 mm for viewing.
- b. Location:
  - .1 At fire and smoke dampers.
  - .2 At control dampers.
  - .3 At devices requiring maintenance.
  - .4 At locations required by code.
  - .5 At reheat coils.
  - .6 Elsewhere as indicated.

**END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCES**

1. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
  - a. SMACNA 1966, HVAC Duct Construction Standards - Metal and Flexible.

## **PRODUCT DATA**

1. Submit product data in accordance with Section 20 05 01 - Mechanical General Requirements.

## **GENERAL**

1. Manufacture to SMACNA standards.

## **SINGLE BLADE DAMPERS**

1. Of same material as duct, but one sheet metal thickness heavier. V-groove stiffened.
2. Size and configuration to recommendations of SMACNA, except maximum height 100 mm (4").
3. For rectangular ducts adjustable lever with shaft extension to accommodate insulation thickness.
4. For round branch ducts adjustable lever with shaft extension to accommodate insulation thickness.
5. Inside and outside nylon end bearings.
6. Channel frame of same material as adjacent duct, complete with angle stop.

## **INSTALLATION**

1. Install where indicated.
2. Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
3. For supply, return and exhaust systems, locate balancing dampers in each branch duct.
4. Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.
5. All dampers to be vibration free.
6. Ensure damper operators are observable and accessible.

**END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCES**

1. American Society for Testing and Materials (ASTM)
  - a. ASTM C177, Standard Test Method for Steady-State Heat Flux and Thermal Measurements Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
2. Canadian General Standards Board (CGSB)
  - a. CAN/CGSB 51.10, Thermal Insulation, Mineral Fibre, Block or Board, for Ducting, Machinery and Boilers.
3. National Fire Protection Association (NFPA)
  - a. NFPA (Fire) 90A, Installation of Air Conditioning and Ventilating Systems.
  - b. NFPA (Fire) 90B, Installation of Warm Air Heating and Air Conditioning Systems.
4. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
  - a. SMACNA 1966, HVAC Duct Construction Standards - Metal and Flexible.
5. Underwriters' Laboratories of Canada
  - a. CAN/ULC S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

## **PRODUCT DATA**

1. Submit product data in accordance with Section 20 05 01 - Mechanical General Requirements.

## **GENERAL**

1. Flame spread rating shall not exceed 25. Smoke developed classification shall not exceed 50 when tested in accordance with CAN/ULC S102.

## **FIBROUS DUCT LINER**

1. Fibrous glass or "textile" fibrous, flexible glass duct liner; air stream side faced with mat facing.
2. Use on flat surfaces where indicated.
3. 25 mm (1") thick, to CAN/CGSB-51.10, fibrous glass flexible duct liner.
4. Density: 24 kg/m<sup>3</sup> (1.5 PCF) minimum.
5. Thermal resistance to be minimum 0.76m<sup>2</sup>·°C/W for 25 mm thickness when tested in accordance with ASTM C177, at 24°C mean temperature.

---

## **FASTENERS**

1. Weld pins 2.0 mm diameter, length to suit thickness of insulation. Metal retaining clips, 32 mm square.

## **JOINT TAPE**

1. Poly-Vinyl treated open weave fibreglass membrane 50 mm wide.

## **SEALER**

1. Meet requirements of NFPA (Fire) 90A and NFPA (Fire) 90B.
2. Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range -68°C to +93°C.

## **GENERAL**

1. Do work in accordance with recommendations of SMACNA duct liner standards as indicated in SMACNA 1966, except as specified otherwise.
2. Line inside of ducts where indicated.
3. Duct dimensions, as indicated, are clear inside duct lining.

## **DUCT LINER**

1. Install in accordance with manufacturer's recommendations, and as follows:
  - a. Fasten to interior sheet metal surface with 100% coverage of adhesive.
  - b. In addition to adhesive, install weld pins not less than two (2) rows per surface and not more than 425 mm on centres.

## **JOINTS**

1. Seal all butt joints, exposed edges, weld pin and clip penetrations and all damaged areas of liner with joint tape and sealer. Install joint tape in accordance with manufacturer's recommendations, and as follows:
  - a. Bed tape in sealer.
  - b. Apply 2 coats of sealer over tape.
2. Replace badly damaged areas of liner at discretion of Engineer.

**END OF SECTION**



## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCES**

1. Air Movement and Control Association (AMCA)
  - a. AMCA 99, Standards Handbook.
  - b. ANSI/AMCA 210, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
  - c. ANSI/AMCA 300, Reverberant Room Method for Sound Testing of Fans.
  - d. ANSI/AMCA 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
2. American Bearing Manufacturers Association (ABMA)
  - a. ABMA 9, Load Ratings and Fatigue Life for Ball Bearings.
  - b. ABMA 11, Load Ratings and Fatigue Life for Roller Bearings.
3. American Society of Heating, Refrigeration and Air-Conditioning (ASHRAE)
  - a. ASHRAE/AMCA 51, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
4. American Society for Testing and Materials International (ASTM)
  - a. ASTM B117-19, Standard Practice for Operating Salt Spray (Fog) Testing.
5. Canadian General Standards Board (CGSB)
  - a. CAN/CGSB 1.181, Coating, Zinc Rich, Organic, Ready Mixed.
6. Canadian Standards Association (CSA).
7. National Fire Protection Association (NFPA)
  - a. NFPA (Fire) 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

## **SHOP DRAWINGS AND PRODUCT DATA**

1. Submit shop drawings and product data in accordance with Section 20 05 01 - Mechanical General Requirements.
2. Provide:
  - a. Fan performance curves showing point of operation, kW (BHP) and efficiency.
  - b. Sound rating data at point of operation.

---

## **OPERATION AND MAINTENANCE DATA**

1. Provide operation and maintenance data for incorporation into manual specified in Section 20 05 01 - Mechanical General Requirements.
2. Furnish list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing, or replacing, for placement into operating manual.

## **MAINTENANCE MATERIALS**

1. Provide maintenance materials in accordance with Section 20 05 01 - Mechanical General Requirements.

## **CERTIFICATION OF RATINGS**

1. Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered from independent testing agency signifying adherence to codes and standards in force.
2. Provide confirmation of testing.

## **UPBLAST ROOF EXHAUSTER**

1. Spun aluminum, upblast exhaust fans shall be direct type as per equipment schedule. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure and a birdscreen.
2. Motors shall be heavy duty ball bearing type, carefully matched to the fan load, and furnished at the specified voltage, phase, and enclosure. Drive frame assembly shall be constructed of heavy gauge steel. Motors and drives shall be mounted on vibration isolators, out of the airstream. Fresh air for motor cooling shall be drawn into the motor compartment through a large space between the fan shroud and the motor cover. Motors and drives shall be readily accessible for maintenance.
3. Supply variable speed controller and turn over to Div. 26 for installation and wiring.
4. Precision ground a polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Drives shall be sized for a minimum of 150% of driven horsepower.
5. All fans shall come with backdraft damper.
6. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance.
7. Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number for future identification.
8. Performance: as indicated on drawing schedule.
9. Acceptable material: Greenheck or Canarm.

### **CEILING HUNG PROPELLER FANS**

1. (PF01) High performance, 1400 mm (56"), reversible motor, industrial, ceiling mounted propeller fan & down rod. Performance: 9,700 L/s at 310 RPM, 120 V/1Ø/ 60 Hz, 97 Watts.
2. Provide speed controller for each fan. Turn over to Division 26 for installation and wiring where indicated.
3. Acceptable material: Canarm Model CP56HPWP or equal.

### **INSTALLATION**

1. Install in accordance with manufacturer's instructions.

### **ANCHOR BOLTS AND TEMPLATES**

1. Size anchor bolts to withstand seismic acceleration and velocity forces as specified in Section 20 05 49.01 - Seismic Restraint System (SRS) for Mechanical Systems.

**END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **PRODUCT DATA**

1. Submit product data in accordance with Section 20 05 01 - Mechanical General Requirements.
2. Indicate the following:
  - a. Capacity.
  - b. Throw and terminal velocity.
  - c. Noise criteria.
  - d. Pressure drop.
  - e. Neck velocity.

## **MANUFACTURED ITEMS**

1. Grilles, registers, and diffusers of same generic type to be product of one manufacturer.

## **CERTIFICATION OF RATINGS**

1. Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

## **GENERAL**

1. To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity as indicated.
2. Coordinate mounting arrangement with ceiling types as shown on architectural drawings.
3. Frames:
  - a. Full perimeter gaskets.
  - b. Plaster frames where set into plaster or gypsum board and as specified.
  - c. Concealed fasteners.
4. Concealed operators.
5. Acceptable material: E.H Price Ltd., Nailor, Titus, Krueger, Metal-aire.

## **SUPPLY DIFFUSERS**

1. Type SD1: steel, plate square diffuser with adjustable pattern 600 mm x 600 mm off-white. Equivalent to E.H. Price Model SCD.

2. Type SD2: aluminum, three cone adjustable diffuser, anodized finish.  
Equivalent to E.H. Price Model RCD.

#### **RETURN AND EXHAUST GRILLES AND REGISTER**

1. Type RG1: aluminum, 13 mm x 13 mm egg crate type face bars, anodized finish, ducted where indicated. Size 600 mm x 150 mm unless otherwise indicated.  
Equivalent to E.H. Price Model 80.
2. Type EG1: steel, 20 mm OC blade spacing, fixed 45° blade angle, white enamel baked finish.  
Sized as indicated on drawings.  
Equivalent to E.H. Price Model 530.

#### **INSTALLATION**

1. Install in accordance with manufacturers instructions.
2. Install with flat head cadmium plated screws in countersunk holes where fastenings are visible.

**END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **SHOP DRAWINGS AND PRODUCT DATA**

1. Submit shop drawings and product data in accordance with Section 20 05 01 - Mechanical General Requirements.

## **OPERATION AND MAINTENANCE DATA**

1. Provide operation and maintenance data for incorporation into manual specified in Section 20 05 01 - Mechanical General Requirements.

## **MAINTENANCE MATERIALS**

1. Provide maintenance materials in accordance with Section 20 05 01 - Mechanical General Requirements.

## **EQUIPMENT**

1. Industrial exhauster, size 375 mm (15") EA-1 top mounted to collector.
2. Capacity: 2,500 L/s (5,300 cfm), 3,500 Pa (14") TSP, approx. 2,250 Pa (9") SP (external).
3. Motor:
  - a. Fan: 20 HP P. EFF TEFC, 208V/3 Phase/60 Hz, 1,800 RPM
  - b. Shaker: 1/2 HP, TEFC, 208V/3 Phase/60 Hz, 1,800 RPM
  - c. Motor side mounted on pedestal c/w sheaves, belts, adjustable slide and open style belt guard
4. Exhauster discharge transition to 400 mm (16") dia. c/w drilled matching flange.
5. Type C spark construction.
6. Acceptable material: N.R. Murphy Model MKAW-705-4D or approved equal.

## **FILTER UNIT**

1. Pull thru design.
2. Constructed from 14 ga. wiped galvanized material.
3. Continuous welded to make air tight.
4. Angle iron reinforced.
5. Electric shaker c/w ½ HP motor and weather cover.

6. 125 mm (5") dia. x 1,640 mm (64½") long filter tubes suspended from shaker rack and fitted air-tight on cell plate. Filters to have a 25 mm x 250 mm (1" x 10") long strap on top to provide tension adjustment.
7. Filters from polyester spun (terylene) 8 oz. per sq. yard with a permeability of 20 to 30 cfm.
8. Air to cloth ratio: 7.5 to 1.
9. 685 mm x 965 mm (27" x 38") filter access doors c/w continuous length hinge and brass pin and explosion relief hardware for an outdoor/negative pressure installation.
10. Inlet section c/w material deflector and inlet c/w matching flanges.
11. Internal inlet blowback prevention damper.
12. 4 x flexible drum connectors, clamps and drum lids.
13. 4 x 45 gal. drums c/w lifting handles.
14. Solid welded support stand with mounting pads.

#### **SILENCER**

1. 450 mm x 1,350 mm (18" dia. x 54" long full flow inline duct silencer c/w silencing media, perforated metal wall and matching drilled flanges both ends.

#### **ELECTRICAL**

1. Prewired EEMAC-12 CSA, approved 575/3/60 voltage control panel c/w:
  - a. Exhauster starter.
  - b. Shaker starter.
  - c. Solid state automatic shaker controller.
  - d. 120V control transformer.
  - e. Push button.
  - f. 2-pilot lights.
  - g. Auxiliary contacts.
  - h. Fused door disconnect.

#### **ACCESSORIES**

1. 400 mm (16") dia. return air fire damper CR type (loose).
2. 400 mm (16") dia. high speed abort damper c/w discharge cowl, 110 V limit switch, weather cowl and drilled flanges both ends.
3. Spark detection and suppression system for 375 mm (15") dia. duct c/w:
  - a. Control panel.
  - b. Battery pack, charger and enclosure.
  - c. 2-IR detectors c/w mounting plates.

- d. Brass strainer.
- e. Water solenoid valve.
- f. Water spray nozzle.
- g. Commissioning at the customer installation location.
- h. Spark detection components shipped in two boxes.

## **INSTALLATION**

1. Install in accordance with manufacturer's instructions.

**END OF SECTION**



## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCES**

1. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)
  - a. ASHRAE 62.1, Ventilation And Acceptable Indoor Air Quality In Residential Buildings
2. American Society for Testing and Materials (ASTM)
  - a. ASTM B117, Standard Practice for Operating Salt Spray (Fog) Apparatus
3. Canadian Standards Association (CSA)
  - a. CSA C22.2 No. 60335-1, Household and similar electrical appliances - Safety - Part 1: General requirements
4. Underwriters Laboratories (UL)
  - a. UL 60335-1, Standard for Safety Household and Similar Electrical Appliances .

## **SHOP DRAWINGS**

1. Submit shop drawings in accordance with Section 20 05 01 - Mechanical General Requirements.
2. Indicate:
  - a. Equipment, piping, and connections, together with valves, strainers, control assemblies, thermostatic controls, auxiliaries and hardware, and recommended ancillaries which are mounted, wired, and piped ready for final connection to building system, its size and recommended bypass connections.
  - b. Piping, valves, fitting shipped loose showing final location in assembly.
  - c. Control equipment shipped loose, showing final location in assembly.
  - d. Complete internal wiring and any external panel wiring, both as schematics and as actually assembled.
  - e. Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, mounting curb details, sizes, and location of mounting bolt holes; include mass distribution drawings showing point loads.
  - f. Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories, controllers.
  - g. Fan performance curves.
  - h. Details of vibration isolation.
  - i. Estimate of sound levels to be expected across each individual octave band in dB referred to A rating.
  - j. Type of refrigerant used.

---

## **MAINTENANCE DATA**

1. Provide maintenance data for incorporation into manual specified in Section 20 05 01 - Mechanical General Requirements.
2. Indicate:
  - a. Brief description of unit, indexed, with details of function, operation, control, and service for each component.
3. Manufacturer's installation instructions shall govern and unless otherwise noted, operation, maintenance, and service of items. Include names and addresses of spare part suppliers.
4. Include following:
  - a. Provide for each unit, manufacturer's name, type, year, number of units, and capacity.

## **PACKAGED ROOFTOP UNIT**

1. Unit Cabinet:
  - a. Unit cabinet shall be constructed of galvanized steel with exterior surfaces coated with a non-chalking, powder paint finish, certified at a 750- hour salt spray test per ASTM-B117 standards.
  - b. Indoor blower sections shall be insulated with up to 1" thick insulation coated on the airside. Either aluminum foil faced or elastometric rubber insulation shall be used in the unit's compartments and be fastened to prevent insulation from entering the air stream.
  - c. Cabinet doors shall be hinged with toolless access for easy servicing and maintenance.
  - d. Full perimeter base rails.
  - e. Fan performance measuring ports shall be provided on the outside of the cabinet to allow accurate air measurements of evaporator fan performance without removing panels or creating bypass of the coils.
  - f. Condensate pan shall be slide out design, constructed of a non corrosive material, internally sloped and conforming to ASHRAE 62-B9 standards. Condensate connection shall be a minimum of ¾" I.D. female and be rigid mount connection.
2. Supply Fan:
  - a. Fan shall be a belt drive assembly and include an adjustable pitch motor pulley. Units shall be designed to operate within the service factor.
  - b. Fan wheel shall be double inlet type with forward curve blades, dynamically balanced to operate smoothly throughout the entire range of operation.
  - c. Bearings shall be sealed and permanently lubricated for longer life and no maintenance.
  - d. Entire blower assembly and motor shall be slide out design.
3. Condenser Fan
  - a. Fans shall be of the direct drive type, discharge air vertically, have aluminum blades riveted to corrosion resistant steel spider brackets.
  - b. Shall be dynamically balanced for smooth operation.

- c. The outdoor fan motors shall have permanently lubricated bearings internally protected against overload conditions and staged independently.
  - d. A cleaning window shall be provided on two sides of the units for coil cleaning.
- 4. Refrigerant Components:
  - a. Compressors: Shall be fully hermetic type, direct drive, internally protected with internal high-pressure relief and over temperature protection. The hermetic motor shall be suction gas cooled and have a voltage range of +/- 10% of the unit nameplate voltage. Shall have internal spring isolation and sound muffling to minimize vibration and noise, and be externally isolated on a dedicated, independent mounting.
  - b. Evaporator Coil: Shall have aluminum plate fins mechanically bonded to seamless internally enhanced copper tubes with all joints brazed. Special Phenolic coating shall be available as a factory option. Evaporator coils shall be of the direct expansion, draw-thru design.
  - c. Condenser Coil: Shall have aluminum plate fins mechanically bonded to seamless internally enhanced copper tubes with all joints brazed or Micro-Channel aluminum tube, aluminum fins. Shall be of the draw-thru design.
  - d. Refrigerant Circuit and Refrigerant Safety Components shall include:
    - .1 Independent fixed-orifice or thermally operated expansion devices.
    - .2 Solid core filter drier/strainer to eliminate any moisture or foreign matter.
    - .3 Accessible service gage connections on both suction and discharge lines to charge, evacuate, and measure refrigerant pressure during any necessary servicing or troubleshooting, without losing charge.
    - .4 The unit shall have two independent refrigerant circuits, equally split in 50% capacity increments.
- 5. Hydronic Heating:
  - a. Coil casing:
    - .1 Steel: 16 ga, die formed galvanized zinc coated steel sheet
    - .2 Tube supports allow for expansion and contraction.
    - .3 Supports: steel channel or double angle frames.
  - b. Coil:
    - .1 Tubes: Copper
    - .2 Fins: Aluminum
    - .3 Headers: Copper
    - .4 Pressure Tests: 1.7 MPa.
- 6. Hot Gas Reheat
  - a. Factory installed to provide dehumidification system utilizing hot refrigerant to maintain supply air temperature control through a electronic three-way valve.
- 7. Energy Recovery Ventilator (ERV)

- 
- a. Cabinet: ERV shall be designed to attach directly to the rooftop unit. Cabinet material to be G90 galvanized material with a powdered enamel paint finish electrostatically bonded to the metal. Cabinet panels shall be fully insulated to prevent sweating and minimize sound. Openings shall be provided for power connections. Lifting devices will be provided for rigging. Test ports shall be provided so airflow can be measured across the energy recovery wheel.
  - b. Intake & Exhaust Air Blowers: ERV shall contain centrifugal blowers equipped with direct drive PSC blower motors. Each motor will be multiple speed and will be individually controlled. Airflow will also be adjustable by means of a damper on the intake air opening. Blowers and motors will be removable through means of a connecting plug for ease of servicing.
  - c. Energy Recovery Wheel: The energy recovery device shall be a rotary heat exchanger per ART Standard 1060 description. The device will be an enthalpy wheel coated with a silica gel desiccant by a patented process without the use of binders or adhesives which may plug the desiccant aperture. The substrate shall be a lightweight polymer. Desiccant shall not dissolve or deliquesce in the presence of water or high humidity. The wheel shall be easily cleanable with standard coil cleaning solution. The wheel will easily be removable from the cabinet for cleaning. All diameter and perimeter seals shall be provided. The energy recovery cassette shall be Underwriters Laboratories Recognized Component for electrical and fire safety.
  - d. Filters:
    - .1 All units shall be provided with mist eliminator type filters in the intake air hood.
    - .2 Pre-filter: MERV-8
    - .3 Final filter: MERV-13
  - e. Power Connection: The ERV shall be provided with a single point power connection for high voltage.
  - f. Low Ambient Kit: Furnish and install the optional low ambient kit to prevent frost formation on the energy recovery wheel.
  - g. Motorized Intake Air Damper: Furnish and install the optional motorized intake air damper.
8. Unit Controls:
- a. Unit controls shall be capable of communicating with the BAS using BACnet.
  - b. Shall be complete with self-contained low-voltage control circuit protected by a resettable circuit breaker on the 24-volt transformer side.
  - c. Unit shall incorporate a lockout circuit which provides reset capability at the space thermostat or base unit should any of the following standard safety devices trip and shut off compressor:
    - .1 Loss-of-charge/Low-pressure switch.
    - .2 High-pressure switch.
    - .3 Freeze condition sensor on evaporator coil. If any of these safety devices trip, the LCD screen will display the alarm message.

- d. Unit shall incorporate "AUTO RESET" compressor over temperature, over current protection.
  - e. Unit shall operate with conventional thermostat designs and have a low voltage terminal strip for easy hook-up.
  - f. Unit control board shall have on-board diagnostics and fault message display.
  - g. Standard controls shall include anti-short cycle and low voltage protection, and permit cooling operation down to a selectable value as low as -17.8°C.
  - h. Control board shall monitor each refrigerant safety switch independently.
9. Electrical:
- a. All unit power wiring shall enter unit cabinet at a single factory provided location and be capable of side or bottom entry.
  - b. Separate side and bottom openings shall be provided for the control wiring.
10. Warranty:
- a. Compressor – 5 Years
  - b. Heat Exchanger (Gas Heating) - 10 Years
  - c. Parts - 1 Year

## **INSTALLATION**

1. Install as per manufacturer's instructions.
2. Manufacturer to certify installation, supervise start-up and commission unit.
3. Submit start-up report for Engineer's review.

**END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **DEFINITIONS**

1. For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.
2. AEL: ratio between total test period less any system downtime accumulated within that period and test period.
3. Downtime: results whenever EMCS is unable to fulfil required functions due to malfunction of equipment defined under responsibility of EMCS contractor. Downtime is measured by duration, in time, between time that Contractor is notified of failure and time system is restored to proper operating condition. Downtime not to include following:
  - a. Outage of main power supply in excess of back-up power sources, provided that:
    - .1 Automatic initiation of back-up was accomplished.
    - .2 Automatic shut-down and re-start of components was as specified.
  - b. Failure of communications link, provided that:
    - .1 Controller automatically and correctly operated in stand-alone mode.
    - .2 Failure was not due to failure of any specified EMCS equipment.
  - c. Functional failure resulting from individual sensor inputs or output devices, provided that:
    - .1 System recorded said fault.
    - .2 Equipment defaulted to fail-safe mode.
    - .3 AEL of total of all input sensors and output devices is at least 99% during test period.

## **DESIGN REQUIREMENTS**

1. Commissioning personnel to be fully aware of and qualified to interpret Design Criteria and Design Intent.

## **ACTION AND INFORMATIONAL SUBMITTALS**

1. Submittals in accordance with Section 20 05 01 - Mechanical General Requirements
2. Final Report: submit report to Consultant.
  - a. Include measurements, final settings and certified test results.
  - b. Bear signature of commissioning technician and supervisor
  - c. Report format to be approved by Consultant before commissioning is started.

- d. Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to EMCS as set during commissioning and submit to Consultant in accordance with Section 20 05 01 - Mechanical General Requirements.
- e. Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

## **CLOSEOUT SUBMITTALS**

1. Provide documentation, O&M Manuals, and training of O&M personnel for review of Consultant before interim acceptance in accordance with Section 20 05 01 - Mechanical General Requirements.

## **COMMISSIONING**

1. Carry out commissioning under direction of and in presence of Commissioning Agent.
2. Inform, and obtain approval from Consultant in writing at least 14 days prior to commissioning or each test. Indicate:
  - a. Location and part of system to be tested or commissioned.
  - b. Testing/commissioning procedures, anticipated results.
  - c. Names of testing/commissioning personnel.
3. Correct deficiencies, re-test in presence of Commissioning Agent until satisfactory performance is obtained.
4. Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.
5. Load system with project software.
6. Perform tests as required.

## **COMPLETION OF COMMISSIONING**

1. Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved and reviewed by Consultant.

## **ISSUANCE OF FINAL CERTIFICATE OF COMPLETION**

1. Final Certificate of Completion will not be issued until receipt of written approval indicating successful completion of specified commissioning activities including receipt of commissioning documentation.

## **EQUIPMENT**

1. Provide sufficient instrumentation to verify and commission the installed system. Provide two-way radios.
2. Instrumentation accuracy tolerances : higher order of magnitude than equipment or system being tested.

3. Independent testing laboratory to certify test equipment as accurate to within approved tolerances no more than 2 months prior to tests.
4. Locations to be approved, readily accessible and readable.
5. Application: to conform to normal industry standards.

## **PROCEDURES**

1. Test each system independently and then in unison with other related systems.
2. Commission each system using procedures prescribed by the Commissioning Agent.
3. Commission integrated systems using procedures prescribed by Commissioning Agent.
4. Debug system software.
5. Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.
6. Test full scale emergency evacuation and life safety procedures including operation and integrity of smoke management systems under normal and emergency power conditions as applicable.

## **FIELD QUALITY CONTROL**

1. Pre-Installation Testing.
  - a. General: consists of field tests of equipment just prior to installation.
  - b. Configure major components to be tested in same architecture as designed system. Include BECC equipment and 2 sets of Building Controller's including MCU's, LCU's, and TCU's.
  - c. Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).
  - d. Additional instruments to include:
    - .1 DP transmitters.
    - .2 VAV supply duct SP transmitters.
    - .3 DP switches used for dirty filter indication and fan status.
  - e. After setting, test zero and span in 10% increments through entire range while both increasing and decreasing pressure.
  - f. Cx Agent to mark instruments tracking within 0.5% in both directions as "approved for installation".
  - g. Transmitters above 0.5% error will be rejected.
  - h. DP switches to open and close within 2% of setpoint.
2. Completion Testing.
  - a. General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.
  - b. Include following activities:



- 
- .1 Test and calibrate field hardware including stand-alone capability of each controller.
  - .2 Verify each A-to-D converter.
  - .3 Test and calibrate each AI using calibrated digital instruments.
  - .4 Test each DI to ensure proper settings and switching contacts.
  - .5 Test each DO to ensure proper operation and lag time.
  - .6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.
  - .7 Test operating software.
  - .8 Test application software and provide samples of logs and commands.
  - .9 Verify each CDL including energy optimization programs.
  - .10 Debug software.
  - .11 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and engineering units. Include space for commissioning technician and Cx Agent. This document will be used in final startup testing.
- c. Final Startup Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of Cx Agent and provide:
- .1 2 technical personnel capable of re-calibrating field hardware and modifying software.
  - .2 Detailed daily schedule showing items to be tested and personnel available.
  - .3 Cx Agent's acceptance signature to be on executive and applications programs.
  - .4 Commissioning to commence during final startup testing.
  - .5 O&M personnel to assist in commissioning procedures as part of training.
  - .6 Commissioning to be supervised by qualified supervisory personnel and Cx Agent.
  - .7 Commission systems considered as life safety systems before affected parts of the facility are occupied.
  - .8 Operate systems as long as necessary to commission entire project.
  - .9 Monitor progress and keep detailed records of activities and results.
- d. Final Operational Testing: to demonstrate that EMCS functions in accordance with contract requirements.
- .1 Prior to beginning of 30 day test demonstrate that operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics and CDL's) have been implemented to ensure proper operation and operator notification in event of off-normal operation.
    - .1 Repetitive alarm conditions to be resolved to minimize reporting of nuisance conditions.

- .2 Test to last at least 30 consecutive 24 hour days.
  - .3 Tests to include:
    - .1 Demonstration of correct operation of monitored and controlled points.
    - .2 Operation and capabilities of sequences, reports, special control algorithms, diagnostics, software.
  - .4 System will be accepted when:
    - .1 EMCS equipment operates to meet overall performance requirements. Downtime as defined in this Section must not exceed allowable time calculated for this site.
    - .2 Requirements of Contract have been met.
  - .5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.
  - .6 Correct defects when they occur and before resuming tests.
- e. Cx Agent to verify reported results.

#### **ADJUSTING**

1. Final adjusting: upon completion of commissioning as reviewed by Cx Agent, set and lock devices in final position and permanently mark settings.

#### **DEMONSTRATION**

1. Demonstrate to Cx Agent operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks and lock-outs.

#### **END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **DEFINITIONS**

1. CDL - Control Description Logic.
2. For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

## **ACTION AND INFORMATIONAL SUBMITTALS**

1. Submittals in accordance with Section 20 05 01 - Mechanical General Requirements, supplemented and modified by requirements of this Section.
2. Submit training proposal complete with hour-by-hour schedule including brief overview of content of each segment to Consultant 30 days prior to anticipated date of beginning of training.
  - a. List name of trainer, and type of visual and audio aids to be used.
  - b. Show co-ordinated interface with other EMCS mechanical and electrical training programs.
3. Submit reports within one week after completion that training program that training has been satisfactorily completed.

## **QUALITY ASSURANCE**

1. Provide competent instructors thoroughly familiar with aspects of EMCS installed in facility.
2. Consultant reserves right to approve instructors.

## **INSTRUCTIONS**

1. Provide instruction to designated personnel in adjustment, operation, maintenance and pertinent safety requirements of EMCS installed.
2. Training to be project-specific.

## **TIME FOR TRAINING**

1. Number of days of instruction to be as specified in this section (1 day = 8 hours including two 15 minute breaks and excluding lunch time).

## **TRAINING MATERIALS**

1. Provide equipment, visual and audio aids, and materials for classroom training.
2. Supply manual for each trainee, describing in detail data included in each training program.
  - a. Review contents of manual in detail to explain aspects of operation and maintenance (O&M).

---

## **TRAINING PROGRAM**

1. The program to begin before 30-day test period at time mutually agreeable to Contractor, and Client.
  - a. Train O&M personnel in functional operations and procedures to be employed for system operation.
  - b. Supplement with on-the-job training during 30-day test period.
  - c. Include overview of system architecture, communications, operation of computer and peripherals, report generation.
  - d. Include detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.
  - e. Equipment maintenance training: provide personnel with training in maintenance of EMCS equipment, including general equipment layout, trouble shooting and preventive maintenance of EMCS components, maintenance and calibration of sensors and controls.
  - f. Programmers: provide personnel in following subjects in approximate percentages of total course shown:

Software and architecture:	10%
Application programs:	15%
Controller programming:	50%
Troubleshooting and debugging:	10%
Color graphic generation:	15%

## **MONITORING OF TRAINING**

1. Cx Agent to monitor training program and may modify schedule and content.

## **END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCES**

1. The Instrumentation, Systems and Automation Society (ISA)
  - a. ISA 5.5, Graphic Symbols for Process Displays.
2. Canadian Standards Association (CSA International).
  - a. CAN/CSA Z234.1, Canadian Metric Practice Guide.
3. Electrical Safety Authority (ESA)
4. Institute of Electrical and Electronics Engineers (IEEE).
  - a. IEEE 260.1, American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).

## **ACRONYMS AND ABBREVIATIONS**

1. Acronyms used in EMCS:
  - a. AEL - Average Effectiveness Level.
  - b. AI - Analog Input.
  - c. AIT - Agreement on International Trade.
  - d. AO - Analog Output.
  - e. BACnet - Building Automation and Control Network.
  - f. DI - Digital Input.
  - g. DO - Digital Output.
  - h. DP - Differential Pressure.
  - i. ECU - Equipment Control Unit.
  - j. EMCS - Energy Monitoring and Control System.
  - k. HVAC - Heating, Ventilation, Air Conditioning.
  - l. IDE - Interface Device Equipment.
  - m. I/O - Input/Output.
  - n. LAN - Local Area Network.
  - o. LCU - Local Control Unit.
  - p. MCU - Master Control Unit.
  - q. NC - Normally Closed.
  - r. NO - Normally Open.

- s. O&M - Operation and Maintenance.
- t. OWS - Operator Work Station.
- u. SP - Static Pressure.

## DEFINITIONS

1. Point: may be logical or physical.
  - a. Logical points: values calculated by system such as setpoints, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.
  - b. Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties, or providing status conditions of contacts or relays which provide interaction with related equipment (stop, start) and valve or damper actuators.
2. Point Name: composed of two parts, point identifier and point expansion.
  - a. Point identifier: comprised of three descriptors, "area" descriptor, "system" descriptor and "point" descriptor, for which database to provide 25 character field for each point identifier. "System" is system that point is located on.
    - .1 Area descriptor: building or part of building where point is located.
    - .2 System descriptor: system that point is located on.
    - .3 Point descriptor: physical or logical point description. For point identifier "area", "system" and "point" will be shortforms or acronyms. Database must provide 25 character field for each point identifier.
  - b. Point expansion : comprised of three fields, one for each descriptor. Expanded form of shortform or acronym used in "area", "system" and "point" descriptors is placed into appropriate point expansion field. Database must provide 32 character field for each point expansion.
  - c. Bilingual systems to include additional point identifier expansion fields of equal capacity for each point name for second language.
    - .1 System to support use of numbers and readable characters including blanks, periods or underscores to enhance user readability for each of the above strings.
3. Point Object Type: points fall into following object types:
  - a. AI (analog input).
  - b. AO (analog output).
  - c. DI (digital input).
  - d. DO (digital output).
  - e. Pulse inputs.
4. Symbols and engineering unit abbreviations utilized in displays: to ISA S5.5.
  - a. Printouts: to IEEE 260.1.
  - b. Refer also to Section 25 05 54 - EMCS: Identification.

---

## SYSTEM DESCRIPTION

1. Refer to control schematics for system architecture.
2. Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:
  - a. Building Controllers.
  - b. Control devices as listed in I/O point summary tables.
  - c. OWS(s).
  - d. Data communications equipment necessary to effect EMCS data transmission system.
  - e. Field control devices.
  - f. Software/Hardware complete with full documentation.
  - g. Complete operating and maintenance manuals.
  - h. Training of personnel.
  - i. Acceptance tests, technical support during commissioning, full documentation.
  - j. Wiring interface co-ordination of equipment supplied by others.
  - k. Miscellaneous work as specified in these sections and as indicated.
3. Design Requirements:
  - a. Design and provide conduit and wiring linking elements of system.
  - b. Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed by Consultant prior to installation.
  - c. Location of controllers as reviewed by Consultant prior to installation.
  - d. Provide utility power to EMCS and emergency power to EMCS as indicated.
  - e. Provide UPS for surge protection and battery back-up for controllers.
  - f. Metric references: in accordance with CAN/CSA Z234.1.
4. Language Operating Requirements:
  - a. Provide English operator selectable access codes.
  - b. Use non-linguistic symbols for displays on graphic terminals wherever possible. Other information to be in English.
  - c. Operating system executive: provide primary hardware-to-software interface specified as part of hardware purchase with associated documentation to be in English.
  - d. System manager software: include in English system definition point database, additions, deletions or modifications, control loop statements, use of high level programming languages, report generator utility and other OS utilities used for maintaining optimal operating efficiency.
  - e. Include, in English:
    - .1 Input and output commands and messages from operator-initiated functions, field related changes and alarms as defined in CDL's or assigned limits (i.e.

commands relating to day-to-day operating functions and not related to system modifications, additions, or logic re-definitions).

- .2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points.
- .3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

## **ACTION AND INFORMATIONAL SUBMITTALS**

- 1. Make submittals in accordance with Section 20 05 01 - Mechanical General Requirements.
- 2. Submit for review:
  - a. Equipment list and systems manufacturers.
  - b. List existing field control devices to be re-used included in tender.
- 3. Quality Control:
  - a. Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.
  - b. Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.
  - c. Submit proof of compliance to specified standards with shop drawings and product data in accordance with Section 25 05 02 - EMCS: Submittals and Review Process. Label or listing of specified organization is acceptable evidence.
  - d. For materials, whose compliance with organizational standards/codes/specifications is not regulated by organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.
  - e. Permits and fees: EMCS Contractor shall apply to the Electrical Safety Authority (ESA) for an ESA Permit for work which fall under the Ontario Electrical Safety Code. Upon completion of work, the EMCS Contractor shall apply for inspection and submit the final inspection report to Engineer prior to occupancy of building.
  - f. Existing devices intended for re-use: submit test report.

## **QUALITY ASSURANCE**

- 1. Have local office within 50 km of project staffed by trained personnel capable of providing instruction, routine maintenance and emergency service on systems,
- 2. Provide record of successful previous installations submitting tender showing experience with similar installations utilizing computer-based systems.
- 3. Have access to local supplies of essential parts and provide 7 year guarantee of availability of spare parts after obsolescence.
- 4. Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.



## QUALIFICATIONS

1. Controls sub-contractor shall provide pricing as per plans and specifications to the prime mechanical contractor.

## EXISTING - CONTROL COMPONENTS

1. Utilize existing control wiring as required.
2. Assume responsibility for controls to be incorporated into EMCS.
  - a. Be responsible for items repaired or replaced by Building Owner.
  - b. Be responsible for repair costs due to negligence or abuse of equipment.
  - c. Responsibility for existing devices terminates upon final acceptance of EMCS.
3. Remove existing controls not re-used or not required. Place in approved storage for disposition as directed.

## DESCRIPTION OF WORK

1. The EMCS systems shall be supplied and installed completely under the EMCS Contractor. Control components shall be BACnet protocol. Provide the necessary control points to monitor, alarm and control the end devices as described in the sequence of operation.
2. The engineering, installation, calibration, software programming and checkout necessary for complete and fully operational EMCS systems, as specified hereafter, shall be provided by the EMCS Contractor.
3. Provide a building automation linking the rooftop units, heating plant, exhaust fans, pumps, AC units, and terminal units, etc. to central control station.
4. Provide controllers for all space controls and provide all 120/24 V transformers. Note: 120 V power to controls transformer by Controls contractor. Electrical power circuits available in-service rooms and in corridors - reference electrical drawings.
5. Provide main building network controller as required to integrate new equipment controls. Main building network controllers to be located in Custodian Room (E1).
6. Refer to plans and specifications for all other items included in the EMCS scope of work.

## ACCEPTABLE CONTROLS CONTRACTOR

1. Refer to list below for acceptable controls contractors:

Company Name	Contact Person	Phone Number	Address	Fax Number
Ainsworth	Angel Medina	613-296-7150	69 Auriga Dr, Ottawa, ON K2E 7X7	
Honeywell	Jim Keesling	416-758-2820		416-758-2740
AIRON (formerly LAR-MEX)	Eric Montambeault	613-747-1563	4-5509 Canotek Road, Ottawa, ON K1B 5L3	613-747-2435
Regulvar	Stephan Riffault	613-565-2129	1250 Old Innes Road, Unit 518, Ottawa, ON L1B 5L3	613-565-8895

---

Trane	Steve MeinckeMatt Flansbury	613-820- 8111613-744- 5396	1024 Morrison Drive, Ottawa, ON K2H 8H71257 Algoma Road, Unit 2, Ottawa, ON K1B 3W7	
Carmichael	Brian Lundy	613-342-7820	3528 Coons Road, Brockville, ON K6T 1A7	613-342- 9048

**MANUFACTURER'S RECOMMENDATIONS**

- 1. Installation: to manufacturer's recommendations.

**END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **DEFINITIONS**

1. Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

## **DESIGN REQUIREMENTS**

1. Preliminary Design Review: to contain following contractor and systems information.
  - a. Location of local office.
  - b. Description and location of installing and servicing technical staff.
  - c. Names of sub-contractors and site-specific key personnel.
  - d. Sketch of site-specific system architecture.
  - e. Specification sheets for each item including memory provided, programming language, speed, type of data transmission.
  - f. Descriptive brochures.
  - g. Sample CDL and graphics (systems schematics).
  - h. Response time for each type of command and report.
  - i. Item-by-item statement of compliance.
  - j. Proof of demonstrated ability of system to communicate utilizing BACnet.

## **ACTION AND INFORMATIONAL SUBMITTALS**

1. Submittals in accordance with Section 20 05 01 - Mechanical General Requirements and coordinate with requirements in this Section.
2. Shop Drawings to consist of electronic pdf copy of design documents, shop drawings, product data and software.
3. Hard copy to be completely indexed and coordinated package to assure compliance with contract requirements and arranged in same sequence as specification and cross-referenced to specification section and paragraph number.

## **SHOP DRAWING REVIEW**

1. Submit shop drawings within 30 working days of award of contract and include following:
  - a. Specification sheets for each item. To include manufacturer's descriptive literature, manufacturer's installation recommendations, specifications, drawings, diagrams, performance and characteristic curves, catalogue cuts, manufacturer's name, trade name, catalogue or model number, nameplate data, size, layout, dimensions, capacity, other data to establish compliance.

- b. Detailed system architecture showing all points associated with each controller and where new EMCS ties into existing control equipment.
- c. Spare point capacity of each controller by number and type.
- d. Controller locations.
- e. Auxiliary control cabinet locations.
- f. Single line diagrams showing cable routings, conduit sizes, spare conduit capacity between control centre, field controllers and systems being controlled.
- g. Valves: complete schedule listing including following information: designation, service, manufacturer, model, point ID, design flow rate, design pressure drop, required Cv, Valve size, actual Cv, spring range, pilot range, required torque, actual torque and close off pressure (required and actual).
- h. Flow measuring stations: complete schedule listing designation, service, point ID, manufacturer, model, size, velocity at design flow rate, manufacturer, model and
- i. Wiring diagrams.
- j. Piping diagrams and hook-ups.
- k. Interface wiring diagrams showing termination connections and signal levels for equipment to be supplied by others.
- l. Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:
  - .1 Sensing element type and location.
  - .2 Transmitter type and range.
  - .3 Associated field wiring schematics, schedules and terminations.
  - .4 Complete Point Name Lists.
  - .5 Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.
  - .6 Software and programming details associated with each point.
  - .7 Manufacturer's recommended installation instructions and procedures.
  - .8 Input and output signal levels or pressures where new system ties into existing control equipment.
- m. Control schematics, narrative description, CDL's fully showing and describing automatic and manual procedure required to achieve proper operation of project, including under complete failure of EMCS.
- n. Graphic system schematic displays of air and water systems with point identifiers and textual description of system, and typical floor plans.
- o. Complete system CDL's including companion English language explanations on same sheet but with different font and italics. CDL's to contain specified energy optimization programs.
- p. Listing of time of day schedules.

- q. Mark up to-scale construction drawing to detail control room showing location of equipment and operator work space.
- r. Type and size of memory with statement of spare memory capacity.
- s. Full description of software programs provided.

#### **QUALITY ASSURANCE**

1. Undertake functional review of preliminary design documents, resolve inconsistencies.
2. Resolve conflicts between contract document requirements and actual items (e.g.: points list inconsistencies).
3. Review interface requirements of materials supplied by others.
4. Review "Sequence of Operations".
5. Consultant retains right to revise sequence or subsequent CDL prior to software finalization without cost to Client.

**END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **DEFINITIONS**

1. BECC - Building Environmental Control Centre.
2. OWS - Operator Work Station.
3. For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

## **ACTION AND INFORMATIONAL SUBMITTALS**

1. Submittals in accordance with Section 20 05 01 - Mechanical General Requirements, supplemented and modified by requirements of this Section.
2. Submit Record Documents and Operation and Maintenance Manual in English and French.
3. Provide soft copies and hard copies in hard-back, 50 mm 3 ring, D-ring binders.
  - a. Binders to be 2/3 maximum full.
  - b. Provide index to full volume in each binder.
  - c. Identify contents of each manual on cover and spine.
  - d. Provide Table of Contents in each manual.
  - e. Assemble each manual to conform to Table of Contents with tab sheets placed before instructions covering subject.

## **O&M MANUALS**

1. Custom design O&M Manuals (both hard and soft copy) to contain material pertinent to this project only, and to provide full and complete coverage of subjects referred to in this Section.
2. Provide 1 complete sets of hard and soft copies prior to system or equipment tests
3. Include complete coverage in concise language, readily understood by operating personnel using common terminology of functional and operational requirements of system. Do not presume knowledge of computers, electronics or in-depth control theory.
4. Functional description to include:
  - a. Functional description of theory of operation.
  - b. Design philosophy.
  - c. Specific functions of design philosophy and system.
  - d. Full details of data communications, including data types and formats, data processing and disposition data link components, interfaces and operator tests or self-test of data link integrity.

- 
- e. Explicit description of hardware and software functions, interfaces and requirements for components in functions and operating modes.
  - f. Description of person-machine interactions required to supplement system description, known or established constraints on system operation, operating procedures currently implemented or planned for implementation in automatic mode.
5. System operation to include:
- a. Complete step-by-step procedures for operation of system including required actions at each OWS.
  - b. Operation of computer peripherals, input and output formats.
  - c. Emergency, alarm and failure recovery.
  - d. Step-by-step instructions for start-up, back-up equipment operation, execution of systems functions and operating modes, including key strokes for each command so that operator need only refer to these pages for keystroke entries required to call up display or to input command.
6. Software to include:
- a. Documentation of theory, design, interface requirements, functions, including test and verification procedures.
  - b. Detailed descriptions of program requirements and capabilities.
  - c. Data necessary to permit modification, relocation, reprogramming and to permit new and existing software modules to respond to changing system functional requirements without disrupting normal operation.
  - d. Software modules, fully annotated source code listings, error free object code files ready for loading via peripheral device
  - e. Complete program cross reference plus linking requirements, data exchange requirements, necessary subroutine lists, data file requirements, other information necessary for proper loading, integration, interfacing, program execution.
  - f. Software for each Controller and single section referencing Controller common parameters and functions.
7. Maintenance: document maintenance procedures including inspection, periodic preventive maintenance, fault diagnosis, repair or replacement of defective components, including calibration, maintenance, repair of sensors, transmitters, transducers, controller and interface firmware's, plus diagnostics and repair/replacement of system hardware.
8. System configuration document:
- a. Provisions and procedures for planning, implementing and recording hardware and software modifications required during operating lifetime of system.
  - b. Information to ensure co-ordination of hardware and software changes, data link or message format/content changes, sensor or control changes in event that system modifications are required.
9. Programmer control panel documentation: provide where panels are independently interfaced with BECC, including interfacing schematics, signal identification, timing diagrams, fully commented source listing of applicable driver/handler.

**END OF SECTION**



## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCES**

1. Canadian Standards Association (CSA International).
  - a. CSA C22.1, The Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.

## **DEFINITIONS**

1. For acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

## **SYSTEM DESCRIPTION**

1. Language Operating Requirements: provide identification for control items in English.

## **ACTION AND INFORMATIONAL SUBMITTALS**

1. Submittals in accordance with Section 20 05 01 - Mechanical General Requirements supplemented and modified by requirements of this Section.

## **NAMEPLATES FOR PANELS**

1. Identify by plastic laminate, 3 mm thick Melamine, matt white finish, black core, square corners, lettering accurately aligned and engraved into core.
2. Sizes: 25 x 67 mm minimum.
3. Lettering: minimum 7 mm high, black.
4. Inscriptions: machine engraved to identify function.

## **NAMEPLATES FOR FIELD DEVICES**

1. Identify by plastic encased cards attached by zip-tie or chain.
2. Sizes: 50 x 100 mm minimum.
3. Lettering: minimum 5 mm high produced from laser printer in black.
4. Data to include: point name and point address.
5. Companion cabinet: identify interior components using plastic enclosed cards with point name and point address.

## **NAMEPLATES FOR ROOM SENSORS**

1. Identify by stick-on labels using point identifier.

2. Letter size: to suit, clearly legible.

### **WARNING SIGNS**

1. Equipment including motors, starters under remote automatic control: supply and install orange coloured signs warning of automatic starting under control of EMCS.
2. Sign to read: "Caution: This equipment is under automatic remote control of EMCS".

### **WIRING**

1. Supply and install numbered tape markings on wiring at panels, junction boxes, splitters, cabinets and outlet boxes.
2. Colour coding: to CSA C22.1. Use colour coded wiring in communications cables, matched throughout system.
3. Controls color: Orange.
4. Power wiring: identify circuit breaker panel/circuit breaker number inside each EMCS panel.

### **CONDUIT**

1. Colour code EMCS conduit.
2. Pre-paint box covers and conduit fittings.
3. Coding: use fluorescent orange paint.

### **T-BAR CEILING**

1. For all equipment above ceilings shall be identified by coloured self-adhesive tab.

### **NAMEPLATES AND LABELS**

1. Ensure that manufacturer's nameplates, CSA labels and identification nameplates are visible and legible at all times.

### **EXISTING PANELS**

1. Correct existing nameplates and legends to reflect changes made during Work.

### **END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.
2. Section 25 05 01 – EMCS: General Requirements.

## **REFERENCES**

1. American National Standards Institute (ANSI)
  - a. IEEE/ANSI C2, National Electrical Safety Code
2. Canadian Standards Association (CSA)
  - a. CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.
  - b. CSA C22.2 No. 0.3, Test Methods for Electrical Wires and Cables.
  - c. CSA C22.2 No. 45, Rigid Metal Conduit.
  - d. CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - e. CSA C22.3 No. 7, Underground Systems.
3. National Fire Protection Association (NFPA)
  - a. NFPA (Fire) 70, National Electrical Code (NEC)

## **SYSTEM DESCRIPTION**

1. Electrical:
  - a. Hard wiring between field control devices and EMCS field panels.
  - b. Communication wiring between EMCS field panels and Master Control Unit (MCU).
  - c. All control wiring 50 V and less for equipment supplied by the Controls Contractor will be the responsibility of the Controls Contractor. Conduit and wire associated with this is the responsibility of the Controls Contractor.
2. Mechanical:
  - a. Pipe taps required for EMCS equipment will be supplied and installed by Mechanical Division.
  - b. Wells and control valves shall be supplied by the Controls Contractor and installed by Mechanical Contractor.
  - c. Installation of air flow stations, dampers, and other devices requiring sheet metal trades to be mounted by Mechanical Contractor.

## **PERSONNEL QUALIFICATIONS**

1. Qualified trained supervisory personnel to:
  - a. Continuously direct and monitor all work.

- b. Attend site meetings.

## **SPECIAL SUPPORTS**

1. Structural grade steel, primed and painted after construction and before installation.

## **WIRING**

1. As per requirements of Electrical Divisions.
2. For 50V and above copper conductor with chemically cross-linked thermosetting polyethylene insulation rated RW90 and 600V. Colour code to CSA 22.1.
3. For wiring under 50 volts use FT6 rated wiring where wiring is not run in conduit. All other cases use FT4 wiring.
4. Sizes:
  - a. 120V Power supply: to match or exceed breaker, size #12 minimum.
  - b. Wiring for safeties/interlocks for starters, motor control centres, to be stranded, #14 minimum.
  - c. Field wiring to digital device: #18AWG or 20AWG stranded twisted pair.
  - d. Analog input and output: shielded #18 minimum solid copper or #20 minimum stranded twisted pair. Wiring must be continuous without joints.
  - e. More than 4 conductors: #22 minimum solid copper.
5. Terminations:
  - a. Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.
6. All wiring within routed above drop ceilings to be supported unit J hooks spaced minimum 1,500mm (5') apart. Hooks to be secured off open web steel joists or building structure. Not to be mounted off pencil rod.
7. Cables to be grouped together using Velcro straps. Zip-ties will not be acceptable.

## **CONDUIT**

1. As per requirements of Electrical Division.
2. Electrical metallic tubing to CSA C22.2 No. 03. Flexible and liquid tight flexible metal conduit to CSA C22.2 No.56. Rigid steel threaded conduit to CSA C22.2 No. 45.
3. Junction and pull boxes: welded steel.
  - a. Surface mounting cast FS: screw-on flat covers.
  - b. Flush mounting: covers with 25 mm minimum extension all round.
4. Cabinets: sheet steel, for surface mounting, with hinged door, latch lock, 2 keys, complete with perforated metal mounting backboard. Panels to be keyed alike for similar functions and or entire contract as approved.
5. Outlet boxes: 100 mm minimum, square.

6. Conduit boxes, fittings:
  - a. Bushings and connectors: with nylon insulated throats.
  - b. With push pennies to prevent entry of foreign materials.
7. Fittings for rigid conduit:
  - a. Couplings and fittings: threaded type steel.
  - b. Double locknuts and insulated bushings: use on sheet metal boxes.
  - c. Use factory "ells" where 90 degree bends required for 25 mm and larger conduits.
8. Fittings for thin wall conduit:
  - a. Connectors and couplings: steel, set screw type.

### **WIRING DEVICES, COVER PLATES**

1. Conform to CSA.
2. Receptacles:
  - a. Duplex: CSA type 5-15R.
  - b. Single: CSA type 5-15R.
  - c. Cover plates and blank plates: finish to match other plates in area.

### **SUPPORTS FOR CONDUIT, FASTENINGS, EQUIPMENT**

1. Solid masonry, tile and plastic surfaces: lead anchors or nylon shields.
  - a. Hollow masonry walls, suspended drywall ceilings: toggle bolts.
2. Exposed conduit:
  - a. 50 mm diameter and smaller: one-hole steel straps.
  - b. Larger than 50 mm diameter: two-hole steel straps.
3. Suspended support systems:
  - a. Individual cable or conduit runs: support with 6 mm diameter threaded rods and support clips.
  - b. Two or more suspended cables or conduits: support channels supported by 6 mm diameter threaded rod hangers.

### **INSTALLATION**

1. Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.

### **SUPPORTS**

1. Install special supports as required and/or as indicated.

---

## **ELECTRICAL GENERAL**

1. Do complete installation in accordance with requirements of:
  - a. Electrical Divisions, this specification.
  - b. CSA 22.1 Canadian Electrical Code, latest edition.
  - c. ANSI/NFPA 70.
  - d. ANSI C2.
2. Fully enclose or properly guard electrical wiring, terminal blocks, high voltage (above 50 V) contacts and mark to prevent accidental injury.
3. Do underground installation to CAN/CSA C22.3 No.7, except where otherwise specified.
4. Conform to manufacturer's recommendations for storage, handling and installation.
5. Check factory connections and joints. Tighten where necessary to ensure continuity.
6. Install electrical equipment between 1000 and 2000 mm above finished floor wherever possible and adjacent to related equipment.
7. Protect exposed live equipment such as panel, mains, outlet wiring during construction for personnel safety.
8. Shield and mark live parts "LIVE 120 VOLTS" or other appropriate voltage.
9. Install conduits, and sleeves prior to pouring of concrete.
10. Holes through exterior wall and roofs: flash and make weatherproof.
11. Make necessary arrangements for cutting of chases, drilling holes and other structural work required to install electrical conduit, cable, pull boxes, outlet boxes.
12. Install cables, conduits and fittings which are to be embedded or plastered over, neatly and closely to building structure to minimize furring.

## **CONDUIT SYSTEM**

1. Communication wiring shall be installed in conduit. Provide complete conduit system to link Field Controllers to Master Control Unit (MCU). Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems. Maximum conduit fills not to exceed 40%. Design drawings do not show conduit layout.
2. Install conduits parallel or perpendicular to building lines, to conserve headroom and to minimize interference.
3. Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Obtain approval from Owner's Representative before starting such work. Provide complete conduit system to link field panels and devices with main control centre. Conduit size to match conductors plus future expansion capabilities as specified.
4. Locate conduits at least 150 mm from parallel steam or hot water pipes and at least 50 mm at crossovers.
5. Bend conduit so that diameter is reduced by less than 1/10th original diameter.
6. Field thread on rigid conduit to be of sufficient length to draw conduits up tight.

7. Limit conduit length between pull boxes to less than 30 m.
8. Use conduit outlet boxes for conduit up to 32 mm diameter and pull boxes for larger sizes.
9. Fastenings and supports for conduits, cables, and equipment:
  - a. Provide metal brackets, frames, hangers, clamps and related types of support structures as indicated and as required to support cable and conduit runs.
  - b. Provide adequate support for raceways and cables, sloped vertically to equipment.
  - c. Use supports or equipment installed by other trades for conduit, cable and raceway supports only after written approval from Owner's Representative.
10. Install polypropylene fish cord in empty conduits for future use.
11. Where conduits become blocked, remove and replace blocked sections.
12. Pass conduits through structural members only after receipt of Owner's Representative's written approval.
13. Conduits may be run in flanged portion of structural steel.
14. Group conduits wherever possible on suspended or surface channels.
15. Pull boxes:
  - a. Install in inconspicuous but accessible locations.
  - b. Support boxes independently of connecting conduits.
  - c. Fill boxes with paper or foam to prevent entry of construction material.
  - d. Provide correct size of openings. Reducing washers not permitted.
  - e. Mark location of pull boxes on record drawings.
  - f. Identify AC power junction boxes, by panel and circuit breaker.
16. Install terminal blocks or strips indicated in cabinets to Electrical Division.
17. Install bonding conductor for 120 volt and above in conduit.

## **WIRING**

1. Install multiple wiring in ducts simultaneously.
2. Do not pull spliced wiring inside conduits or ducts.
3. Use CSA certified lubricants of type compatible with insulation to reduce pulling tension.
4. Tests: use only qualified personnel. Demonstrate that:
  - a. Circuits are continuous, free from shorts, unspecified grounds.
  - b. Resistance to ground of all circuits is greater than 50 Megohms.
5. Provide Owner's Representative with test results showing locations, circuits, results of tests.
6. Remove insulation carefully from ends of conductors and install to manufacturer's recommendations. Accommodate all strands in lugs. Where insulation is stripped in excess, neatly tape so that only lug remains exposed.

7. Wiring in main junction boxes and pull boxes to terminate on terminal blocks only, clearly and permanently identified. Junctions or splices not permitted for sensing or control signal covering wiring.
8. Do not allow wiring to come into direct physical contact with compression screw.
9. Install ALL strands of conductor in lugs of components. Strip insulation only to extent necessary for installation.

## **WIRING DEVICES, COVER PLATES**

1. Receptacles:
  - a. Install vertically in gang type outlet box when more than one receptacle is required in one location.
  - b. Cover plates:
    - .1 Install suitable common cover plate where wiring devices are grouped.
    - .2 Use flush type cover plates only on flush type outlet boxes.

## **STARTERS, CONTROL DEVICES**

1. Install and make control connections as indicated. Power connections above 50V by Electrical Division.
2. Install correct over-current devices.
3. Identify each control wire, terminal for external connections with permanent number marking identical to diagram.
4. Performance Verification:
  - a. Operate switches and controls to verify functioning.
  - b. Perform start and stop sequences of contactors and relays.
  - c. Check that interlock sequences, with other separate related starters, equipment and auxiliary control devices, operate as specified.

## **GROUNDING**

1. Install complete, permanent, continuous grounding system for equipment, including conductors, connectors and accessories.
2. Install separate grounding conductors in conduit within building.
3. Install ground wire in all PVC ducts and in tunnel conduit systems.
4. Tests: perform ground continuity and resistance tests, using approved method appropriate to site conditions.

## **IDENTIFICATION**

1. Refer to Section 25 05 54- EMCS: Identification.

**END OF SECTION**



## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.
2. References.
  - a. Canada Labour Code (R.S., c. L-2)/Part I - Industrial Relations.
  - b. Canadian Standards Association (CSA International).
    - .1 CSA Z204, Guidelines for Managing Indoor Air Quality in Office Buildings.

## **DEFINITIONS**

1. BC(s) - Building Controller(s).
2. OWS - Operator Work Station.
3. For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

## **ACTION AND INFORMATIONAL SUBMITTALS**

1. Submittals in accordance with Section 20 05 01 - Mechanical General Requirements.

## **MAINTENANCE SERVICE DURING WARRANTY PERIOD**

1. Provide services, materials, and equipment to maintain EMCS for specified warranty period. Provide detailed preventative maintenance schedule for system components as described in Submittal article.
2. Emergency Service Calls:
  - a. Initiate service calls when EMCS is not functioning correctly.
  - b. Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.
  - c. Furnish telephone number where service personnel may be reached at any time.
  - d. Service personnel to be on site ready to service EMCS within 2 hours after receiving request for service.
  - e. Perform Work continuously until EMCS restored to reliable operating condition.
3. Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of EMCS based on original design conditions and as recommended by manufacturer.
4. Work requests: record each service call request, when received separately on approved form and include:
  - a. Serial number identifying component involved.
  - b. Location, date and time call received.
  - c. Nature of trouble.

- d. Names of personnel assigned.
  - e. Instructions of work to be done.
  - f. Amount and nature of materials used.
  - g. Time and date work started.
  - h. Time and date of completion.
5. Provide system modifications in writing.
- a. No system modification, including operating parameters and control settings, to be made without prior written approval of Consultant.

## **FIELD QUALITY CONTROL**

1. Perform as minimum (3) three minor inspections and one major inspection (more often if required by manufacturer) per year. Provide detailed written report to Client as described in Submittal article.
2. Perform inspections during regular working hours, 08:00 to 16:30, Monday through Friday, excluding statutory holidays.
3. Following inspections are minimum requirements and should not be interpreted to mean satisfactory performance:
  - a. Perform calibrations using test equipment having traceable, certifiable minimum accuracy at 50% greater than accuracy of system displaying or logging value.
  - b. Check and Calibrate each field input/output device in accordance with Canada Labour Code - Part I and CSA Z204.
  - c. Provide dated, maintenance task lists, as described in Submittal article, as proof of execution of complete system verification.
4. Minor inspections to include, but not limited to:
  - a. Perform visual, operational checks to BC's, peripheral equipment, interface equipment and other panels.
  - b. Check equipment cooling fans as required.
  - c. Visually check for mechanical faults, air leaks and proper pressure settings on pneumatic components.
  - d. Review system performance with Operations Supervisor to discuss suggested or required changes.
5. Major inspections to include, but not limited to:
  - a. Minor inspection.
  - b. Clean OWS(s) peripheral equipment, BC(s), interface and other panels, micro-processor interior and exterior surfaces.
  - c. Check signal, voltage and system isolation of BC(s), peripherals, interface and other panels.

- 
- d. Verify calibration/accuracy of each input and output device and recalibrate or replace as required.
  - e. Provide mechanical adjustments, and necessary maintenance on printers.
  - f. Run system software diagnostics as required.
  - g. Install software and firmware enhancements to ensure components are operating at most current revision for maximum capability and reliability.
    - .1 Perform network analysis and provide report as described in Submittal article.
  - 6. Rectify deficiencies revealed by maintenance inspections and environmental checks.
  - 7. Continue system debugging and optimization.
  - 8. Testing/verification of occupancy and seasonal-sensitive systems to take place during four (4) consecutive seasons, after facility has been accepted, taken over and fully occupied.
    - a. Test weather-sensitive systems twice: first at near winter design conditions and secondly under near summer design conditions.

**END OF SECTION**

## **RELATED SECTIONS**

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## **REFERENCES**

1. American National Standards Institute (ANSI).
2. American Society of Mechanical Engineers (ASME).
3. Canadian Standards Association (CSA International).
4. National Electrical Manufacturer's Association (NEMA).

## **DEFINITIONS**

1. Acronyms and Definitions: refer to Section 25 05 01 - EMCS: General Requirements.

## **EXISTING CONDITIONS**

1. Repair surfaces damaged during execution of Work.
2. Turn over to Client existing materials removed from Work not identified for re-use.

## **GENERAL**

1. Control devices of each category to be of same type and manufacturer.
2. External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, shockproof, vibration-proof and heat resistant assembly.
3. Operating conditions: 0-32°C with 10-90% RH (non-condensing) unless otherwise specified.
4. Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.
5. Transmitters and sensors to be unaffected by external transmitters including walkie talkies.
6. Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.
7. Outdoor installations: use weatherproof construction in NEMA 4 enclosures.
8. Devices installed in user occupied space does not exceed Noise Criteria (NC) of 30. Noise generated by any device must not be detectable above space ambient conditions.

## **TEMPERATURE SENSORS**

1. General: except for room sensors to be resistance or thermocouple type to following requirements:
  - a. Thermocouples: limit to temperature range of 200°C and over.

- b. RTD's: 100 or 1000 ohm at 0°C ( $\pm 0.2$  ohms) platinum element with strain minimizing construction, 3 integrals anchored leadwires. Coefficient of resistivity: 0.00385 ohms/ohm°C.
- c. Sensing element: hermetically sealed.
- d. Stem and tip construction: copper or type 304 stainless steel.
- e. Time constant response: less than 3 seconds to temperature change of 10°C.
- f. Immersion wells: NPS  $\frac{3}{4}$ , stainless steel spring loaded construction, with heat transfer compound compatible with sensor.

## **HUMIDITY SENSORS**

- 1. Room and Duct Requirements:
  - a. Range: 5-90% RH minimum.
  - b. Operating temperature range: 0-60°C.
  - c. Absolute accuracy:
    - .1 Duct sensors:  $\pm 3\%$ .
    - .2 Room sensors:  $\pm 2\%$ .
  - d. Sheath: stainless steel with integral shroud for specified operation in air streams of up to 10 m/s.
  - e. Maximum sensor non-linearity:  $\pm 2\%$  RH with defined curves.
  - f. Room sensors: wall mounted as indicated.
  - g. Duct mounted sensors: locate so that sensing element is in air flow in duct.

## **PRESSURE TRANSDUCERS**

- 1. Requirements:
  - a. Combined sensor and transmitter measuring pressure.
    - .1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.
  - b. Output signal: 4-20 mA into 500 ohm maximum load.
  - c. Output variations: less than 0.2% full scale for supply voltage variations of  $\pm 10\%$ .
  - d. Combined non-linearity, repeatability, and hysteresis effects: not to exceed  $\pm 0.5\%$  of full scale output over entire range.
  - e. Temperature effects: not to exceed  $\pm 1.5\%$  full scale/50°C.
  - f. Over-pressure input protection to at least twice rated input pressure.
  - g. Output short circuit and open circuit protection.
  - h. Accuracy:  $\pm 1\%$  of Full Scale.

---

## **CONTROL VALVES**

1. Body: globe style or characterized ball.
  - a. Flow characteristic equal percentage.
  - b. Flow factor (kV) as indicated on control valve schedule: CV in imperial units.
  - c. Normally open or normally closed, as indicated.
  - d. Two or three port, as indicated.
  - e. Leakage rate ANSI class IV, 0.01% of full open valve capacity.
  - f. Packing easily replaceable.
  - g. Stem, stainless steel.
  - h. Plug and seat, stainless steel.
  - i. Disc, replaceable, material to suit application.
  - j. NPS 2 and under:
    - .1 Screwed National Pipe Thread (NPT) tapered female connections.
    - .2 Valves to ANSI Class 250, valves to bear ANSI mark.
    - .3 Rangeability 50:1 minimum.
  - k. Acceptable material: Belimo Zone Tight valves.

## **ELECTRONIC/ELECTRIC VALVE ACTUATORS**

1. Requirements:
  - a. Construction: steel, cast iron, aluminum.
  - b. Control signal: 0-10V DC or 4-20 mA DC.
  - c. Positioning time: to suit application. 90 sec maximum.
  - d. Fail to normal position as indicated.
  - e. Scale or dial indication of actual control valve position.
  - f. Size actuator to meet requirements and performance of control valve specifications.
  - g. For interior and perimeter terminal heating and cooling applications floating control actuators are acceptable.
  - h. Minimum shut-off pressure: to suit application.

## **PANELS**

1. Wall mounted enamelled steel cabinets with hinged and key-locked front door.
2. Multiple panels as required to handle requirements with additional space to accommodate 25% additional capacity without adding additional cabinets.
3. Panels to be lockable with same key.

---

## **WIRING & CONDUITS**

1. In accordance with Section 26 27 26 - Wiring Devices & Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
2. For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. Other cases use FT4 wiring.
3. Wiring must be continuous without joints.
4. Sizes:
  - a. Field wiring to digital device: #18AWG or 20AWG stranded twisted pair.
  - b. Analog input and output: shielded #18 minimum solid copper or #20 minimum stranded twisted pair.
5. Minimum conduit size for power circuits: 21 mm ( $\frac{3}{4}$ ").

## **INSTALLATION**

1. Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.
2. Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.
3. Support field-mounted panels, transmitters and sensors on pipe stands or channel brackets.
4. Fire stopping: provide space for fire stopping. Maintain fire rating integrity.
5. Electrical:
  - a. Complete installation in accordance with Section 26 05 00 - Common Work Results for Electrical.
  - b. Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.
  - c. Trace existing control wiring installation and provide updated wiring schematics including additions and deletions to control circuits before beginning Work.
  - d. Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.
  - e. Install communication wiring in conduit.
    - .1 Provide complete conduit system to link Building Controllers, field panels and OWS(s).
    - .2 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.
    - .3 Maximum conduits fill not to exceed 40%.
    - .4 Design drawings do not show conduit layout.
  - f. Do not run exposed conduits in normally occupied spaces unless otherwise indicated. Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit. All wiring must be in conduit.

- g. Control wiring shall not be installed in same conduit as power wiring.
- 6. Install thermostats at 1200 mm AFF for barrier free applications, and at 1500 mm AFF elsewhere.

### **TEMPERATURE AND HUMIDITY SENSORS**

- 1. Stabilize to ensure minimum field adjustments or calibrations.
- 2. Readily accessible and adaptable to each type of application to allow for quick easy replacement and servicing without special tools or skills.
- 3. Duct installations:
  - a. Do not mount in dead air space.
  - b. Locate within sensor vibration and velocity limits.
  - c. Securely mount extended surface sensor used to sense average temperature.
  - d. Thermally isolate elements from brackets and supports to respond to air temperature only.
  - e. Support sensor element separately from coils, filter racks.
- 4. Thermowells: install for piping installations.
  - a. Locate well in elbow where pipe diameter is less than well insertion length.
  - b. Thermowell to restrict flow by less than 30%.
  - c. Use thermal conducting paste inside wells.

### **PANELS**

- 1. Arrange for conduit and tubing entry from top, bottom or either side.
- 2. Wiring and tubing within panels: locate in trays or individually clipped to back of panel.
- 3. Identify wiring and conduit clearly.

### **IDENTIFICATION**

- 1. Identify field devices in accordance with Section 25 05 54 - EMCS: Identification.

### **TESTING AND COMMISSIONING**

- 1. Calibrate and test field devices for accuracy and performance in accordance with Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.
- 2. Furnish Certificates of Acceptance from Electrical Inspection Department and authorities having jurisdiction on completion of work to Engineer and include in manuals. Final payment will not be made until certificates have been submitted.

### **END OF SECTION**



## RELATED SECTIONS

1. This section shall be read in conjunction with specification Section 20 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

## REFERENCES

## SEQUENCES

1. General:
  - a. Reference Points Lists, Drawings and this section for complete Operating Sequences.
2. Constant Volume Air Handling Units Equipped with Energy Recovery and Perimeter Heating:
  - a. Start-up:
    - .1 Occupied operation begins when the unit is placed in Occupied via BAS.
    - .2 Supply Fan: After completing initial startup, the supply fan startup sequence will begin by enabling the Supply Fan Start Stop Command and setting the Supply Fan Speed Command to 50% for the initial 90 seconds of operation.
  - b. Scheduling:
    - .1 RTU units to be scheduled in occupied mode on an adjustable time schedule, as per the School Board standards. Evenings, Saturday, Sunday & holidays shall be unoccupied mode. Each unit to be scheduled individually.
  - c. Supply Fan Control:
    - .1 Fan speed will be set during balancing.
  - d. Exhaust Fan Control:
    - .1 After completing the exhaust fan startup sequence, the exhaust fan controls to maintain a building static pressure of 25 Pa (user adjustable) relative to the outdoors. If above setpoint, increase the speed of the exhaust fan. If below setpoint, reduce the speed of the exhaust fan.
  - e. Discharge Temperature Control:
    - .1 Dehumidification Mode:
      - .1 Enabled when the space humidity rises 5% above the humidity setpoint. In Dehumidification Mode, cooling is controlled to the Dehumidification Temperature Setpoint, and hot gas reheat controls to the Discharge Air Temperature Setpoint.
    - .2 Morning Warm-up:
      - .1 The discharge air temperature setpoint will be increased to 25°C (user adjustable)
      - .2 The RTU shall run in full recirculation mode.
    - .3 Heating Mode:

- .1

After the initial 2 hour morning warm-up period (user adjustable), the discharge air temperature will be reset to 20°C.

.4

Cooling Mode:

.1

When the room temperature is above the setpoint, the perimeter heating valves begin to close. When the perimeter heating valve is at 0%, the discharge air temperature set-point will be reduced by 1°C every 5 minutes until the room setpoint is achieved.

.2

When the room temperature is below the setpoint, the discharge air temperature will be increased by 1°C every 5 minutes up to the upper discharge temperature limit. If the room temperature is still below setpoint, the perimeter control valves will be modulated.

.3

The discharge air temperature will be modulated between the following limits (user adjustable):

Lower Limit	12°C
Upper Limit	20°C

.5

Provide space temperature limits on the all space sensors to limit occupant adjustability 2°C above the summer and winter set-points.

f.

Energy Recovery Wheel:

.1

Wheel to be enabled & disabled and controlled by the unit controller.

g.

Ventilation:

.1

The BAS shall adjust the outdoor air damper to maintain the return CO<sub>2</sub> setpoint of 1,000 PPM.

.2

During balancing determine the minimum outdoor air damper position to coincide with minimum exhaust air speed to maintain building pressurization.

h.

Unoccupied Mode:

.1

In unoccupied mode the unit will use 100% return air.

.2

Cooling mode: Enabled when the space temperature is above the unoccupied cooling enable setpoint and remains until space temperature is 1°C (user adjustable) below set-point.

.3

Heating mode: Enabled when the space temperature is below the unoccupied heating enable setpoint and remains until space temperature is 2°C (user adjustable) above setpoint.

.4

Dehumidification mode: Enabled when space humidity is above the unoccupied humidity enable setpoint and remains until space humidity is 5% below setpoint.

i.

Morning Warm-up:

.1

Shall be enabled at 6:00am (user adjustable). Supply air temperature to be set at 26°C.

.2

The RTU shall run in full recirculation mode.

3.

Perimeter Heating:

N45 Architecture Inc.

2025-633-(2026-04-10)-M-Spec-Issued for Tender Rev. 1 – MAR 2026

- a. Upon call for heat, coil control valve to open initially to 15%. Valve to modulate as required to maintain the associated room temperature setpoint.
- 4. Glycol Heating System:
  - a. Glycol heating loop to be enabled when the building heating system is enabled.
  - b. Glycol pumps to be enabled and modulated to maintain a differential pressure between the supply and return lines of 35 kPa (5 PSI) (user adjustable). Lower limit of pump speed to be set to 30%.
    - .1 If the differential pressure is too high, and the pump is at 30%, bypass valve to be modulated.
    - .2 If the differential pressure is too low, bypass valve to be modulated until fully closed, prior to pump speed being increased.
  - c. Heating water flow to be modulated to maintain a glycol supply temperature based on the reset schedule below:

Outdoor Air Temperautre	Glycol Supply Temperature
> 15°C	60°C
< -5°C	80°C

**END OF SECTION**

70 Years of Mechanical & Electrical Engineering Excellence



**1000 Edward St. North - Prescott, ON  
South Grenville District High School  
Architectural Services - UCDSB - RFQ #25-101**

**ELECTRICAL SPECIFICATION  
Issued for Tender R1**

**GWAL 2025-633**  
April 13, 2026



**Prepared By:**  
Amy Girard | Senior Electrical Designer

**Reviewed By:**  
Richard Boivin, P.Eng., ing. | Director, Electrical Engineer

**Division 26 - Electrical**

SECTION 26 05 00 COMMON WORK RESULTS FOR ELECTRICAL .....	14
SECTION 26 05 04 SEISMIC RESTRAINT SYSTEMS (SRS).....	4
SECTION 26 05 20 WIRE AND BOX CONNECTORS (0-1000 V) .....	2
SECTION 26 05 21 WIRES AND CABLES (0-1000 V) .....	2
SECTION 26 05 28 GROUNDING - SECONDARY .....	2
SECTION 26 05 29 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS .....	1
SECTION 26 05 31 SPLITTERS, JUNCTION, PULL BOXES AND CABINETS.....	1
SECTION 26 05 32 OUTLET BOXES, CONDUIT BOXES AND FITTINGS .....	2
SECTION 26 05 34 CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS .....	2
SECTION 26 24 01 DISTRIBUTION EQUIPMENT LOW VOLTAGE.....	3
SECTION 26 27 26 WIRING DEVICES.....	3
SECTION 26 29 10 MOTOR STARTERS TO 600 V .....	2
SECTION 26 50 00 LIGHTING EQUIPMENT .....	2

**DIVISION 28 - ELECTRONIC SAFETY AND SECURITY**

SECTION 28 31 00.02 ADDRESSABLE MULTIPLEX FIRE ALARM SYSTEMS .....	12
--------------------------------------------------------------------	----

## **PART 1 GENERAL**

### **1.1 GENERAL**

- .1 All references to OBC/NBC shall be to the version in effect as at the time of the permit application.
- .2 All references to codes/standards/etc. throughout the specification shall be to the version referenced by OBC/NBC (whichever is applicable) as at the time of the permit application. References to codes/standards/etc. that are not referenced by OBC/NBC shall be to the latest version as at the time of tender.
- .3 Provide shall mean supply, install, connect, test and commission.
- .4 Commence work upon notification of acceptance of offer, or as outlined in the approved construction schedule.
- .5 Verify equipment delivery times immediately and notify engineer within two (2) weeks of contract award of any deliveries which would affect schedule.
- .6 Comply with National Building Code (Part 8, Safety Measures at Construction and Demolition Sites) and Provincial Regulations for Construction Projects.

### **1.2 REFERENCES**

- .1 Definitions:
  - .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE 100 CD.
- .2 Reference Standards use current enforced edition of the following:
  - .1 CSA Standards.
    - .1 CSA C22.1, Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.
    - .2 CSA C235, Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
  - .2 Electrical Safety Authority (ESA)
    - .1 Ontario Electrical Safety Code (OESC).
  - .3 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
    - .1 IEEE 100 CD, Standards Dictionary: Glossary of Terms and Definitions.
  - .4 Inspection authorities shall mean Electrical Safety Authority.
  - .5 National Fire Protection Association (NFPA).
  - .6 Ontario Fire Code.
  - .7 Ontario Regulation
    - .1 ONTARIO OBC, Ontario Building Code.
  - .8 Underwriters Laboratories of Canada (ULC)
    - .1 CAN-ULC-S524, Standard for the Installation of Fire Alarm Systems.

### 1.3 ACTION AND INFORMATION 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 and include product characteristics, performance criteria, physical size, finish, and limitations.
- .3 Submit for review as-built single line electrical diagrams to be installed under plexiglass as follows:
  - .1 Electrical distribution system in main electrical room.
  - .2 Electrical power generation and emergency distribution systems.
- .4 Submit for review fire alarm graphic, plan, and zoning of building under plexiglass at fire alarm control panel and annunciator.
- .5 Shop drawings:
  - .1 Submit single electronic format (pdf) of shop drawings and product data along with transmittal. Hard copy shop drawings shall not be accepted.
  - .2 The review is for the sole purpose of ascertaining conformance with the general design concept and does not mean approval of the design details inherent in the shop drawings, responsibility for which shall remain with the Contractor. Such review shall not relieve the Contractor of responsibility for errors or omissions in the shop drawings or of his responsibility for meeting all requirements of the Contract Documents.
  - .3 Do not commence manufacture or order materials before shop drawings are reviewed.
  - .4 Shop drawings shall clearly indicate:
    - .1 Name of Contractor.
    - .2 Name of component.
    - .3 Name of service or system.
    - .4 Contractors signed review stamp.
  - .5 Shop drawings shall include, but is not limited to, the following information:
    - .1 Arrangement of specific system.
    - .2 Electrical characteristics, volts, phase, amps, etc.
    - .3 Dimensions of equipment and required clearances.
    - .4 Performance data.
    - .5 Finish.
    - .6 Gauge of materials.
    - .7 Wiring diagrams (where applicable).
    - .8 Product data (where applicable).
  - .6 Review relevant shop drawings of other Divisions to ensure interface of systems with respect to wiring, voltages, ampacities, phases, size, controls, etc. Notify Engineer of any discrepancies immediately.
  - .7 Provide shop drawings for equipment as indicated in this specification.
  - .8 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.

- .9 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
- .10 Indicate on drawings clearances for operation, maintenance, and replacement of operating equipment devices.
- .11 Submit required number of copies of drawings and product data to inspection authorities.
- .12 If changes are required, notify Engineer of these changes before they are made.
- .6 Certificates:
  - .1 Provide CSA certified equipment and material.
  - .2 Where CSA certified equipment and material is not available, submit such equipment and material to inspection authorities for special approval before delivery to site.
  - .3 Submit test results of installed electrical systems and instrumentation.
  - .4 Permits and fees: in accordance with General Conditions of contract.
  - .5 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Engineer.
- .7 Manufacturer's Field Reports: submit to Engineer manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in PART 3 - FIELD QUALITY CONTROL.

#### 1.4 CLOSEOUT SUBMITTALS

- .1 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.
  - .1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
  - .2 Operating instructions to include following:
    - .1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
    - .2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
    - .3 Safety precautions.
    - .4 Procedures to be followed in event of equipment failure.
    - .5 Other items of instruction as recommended by manufacturer of each system or item of equipment.
  - .3 Post engraved operating instructions where directed.
  - .4 Submit pdf for review and submit final version in and pdf.

#### 1.5 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 and equipment in accordance with manufacturer's recommendations in clean, dry, well-ventilated, heated area.



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

#### **1.6 GENERAL**

- .1 Provide shall mean supply, install, connect, test and commission.
- .2 Commence work upon notification of acceptance of offer, or as outlined in the approved construction schedule.
- .3 Verify equipment delivery times immediately and notify engineer within two (2) weeks of contract award of any deliveries which would affect schedule.
- .4 Comply with National Building Code (Part 8, Safety Measures at Construction and Demolition Sites) and Provincial Regulations for Construction Projects.

#### **1.7 EXISTING SERVICES**

- .1 Existing services required for work may be used by the Contractor with the Owners written consent. Ensure capacity is adequate prior to imposing additional loads. Connect and disconnect at own expense and responsibility.
- .2 Notify the Owner a minimum of 72 hours in advance of intended interruption of services; obtain requisite permissions.
- .3 Keep duration of these interruptions to a minimum. Carry out all interruptions after normal working hours of the occupants, preferably on weekends or as approved by the Owner in writing.
- .4 Any unscheduled disruption to services to be immediately reinstated.
- .5 Existing fire alarm and security systems are to remain fully functional, throughout, provide conduit and wire as required to maintain services during construction.

#### **1.8 EXAMINATION**

- .1 Examine site and conditions which will affect the work. Submission of tender shall be deemed as confirmation that tenderer has inspected site and is conversant with conditions and shall not constitute additional costs as a result of site conditions.
- .2 Verify existing conditions including but not limited to, structural elements, sprinkler piping and heads, roof drains and storm sewer piping, electrical conduit and wiring, process utility piping, ductwork, and other building services.
- .3 The fact that not all existing conditions discussed in Item .2 above are shown on the drawings does not relieve the responsibility of coordinating the work with the existing construction.

#### **1.9 CO-ORDINATION**

- .1 Co-ordinate the work with all other Divisions, to ensure systems compatibility, and to ensure schedules and requirements are maintained.
- .2 Where perceived interferences occur, prepare detailed sketches indicating proposed solution for review and acceptance by Engineer.

#### **1.10 AS-BUILT DRAWINGS**

- .1 Site records:
  - .1 Electrical sub-contractor shall mark all changes as work progresses and as changes occur.
  - .2 On a weekly basis, transfer information to record set of documents, revising to show all work as actually installed.

- .3 Use different colour waterproof ink for each service.
- .4 Make available for reference purposes and inspection at all times.
- .2 As-built drawings:
  - .1 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows:  
- "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW ELECTRICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (date).
  - .2 Engineer to submit AutoCAD files of electrical drawings to contractor. Contractor shall modify CAD Drawings in accordance with Engineer CAD standards to reflect electrical systems as installed.
  - .3 Submit electronic PDF files to Engineer for approval and make corrections as directed.
  - .4 Following approval, submit completed hard copy as-built drawings with Operating and Maintenance Manuals.

#### **1.11 GUARANTEES AND WARRANTIES**

- .1 Before completion of work, collect all manufacturer's signed guarantees and warranties and submit to the Engineer.
- .2 Identify, bind, and index material in maintenance manuals.
- .3 Submit a written, signed guarantee stating that all systems and components have been installed to manufacturers recommendations and that systems are operating satisfactorily and meet the design requirements, and all material and labour deficiencies will be corrected, at no cost, for a period of one year after substantial completion. In addition, submit extended warranties and guarantees as identified in this specification.

#### **1.12 CONTRACT DOCUMENTS**

- .1 Drawings and specifications are complementary, items shown or mentioned in one and not in the other are deemed to be included in the contract work.
- .2 The contract documents are intended to describe complete fully functional systems although not all components are indicated. Provide all required conduits, wiring, equipment, etc. to provide fully functional systems which meet the design intent.
- .3 Discrepancies in the design documents or doubt as to the full intent of the design shall be brought to the Engineer's attention prior to tender close. Failure to do this means that the Contractor is fully aware and shall be responsible of design intent and requirements and shall provide fully functional and coordinated systems.

#### **1.13 COST BREAKDOWN**

- .1 Within one (1) week of award of contract, submit breakdown of costs as separate amounts of labour, materials, etc. of each system. Break down electrical systems generally as follows:
  - .1 Mobilization and start-up.
  - .2 Permits and inspections.
  - .3 Site work.
  - .4 Distribution.
  - .5 Coordination study.
  - .6 Branch circuit roughing.
  - .7 Wiring devices.

- .8 Lighting:
  - .1 Interior.
- .9 Fire alarm.
- .10 Security.
- .11 Data system.
- .2 After review and approval, cost breakdown will be used as the basis of progress payments.

#### **1.14 PERMITS, FEES, AND INSPECTIONS**

- .1 Submit to Electrical Inspection Department and Supply Authority necessary number of drawings and specifications for examination and approval prior to commencement of work.
- .2 Pay associated fees.
- .3 Notify Engineer of changes required by Electrical Inspection Department prior to making changes.
- .4 Furnish Certificates of Acceptance from Electrical Inspection Department and authorities having jurisdiction on completion of work to Engineer and include in manuals. Final payment will not be made until certificates have been submitted.

#### **1.15 TRADE QUALIFICATIONS**

- .1 The work shall be carried out by licensed electricians with who holds valid Ontario Certificates of Qualifications, and current contractor's license.
- .2 Contractor to carry valid current Contractor's License.
- .3 The ratio of Journeymen to Apprentices shall not exceed the ratio in the Trade Qualifications and Apprenticeship Act of Ontario.
- .4 Submit list of employees and qualifications for all personnel on site upon request.

### **PART 2 PRODUCTS**

#### **2.1 DESIGN REQUIREMENTS**

- .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.
  - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- .3 Language operating requirements: provide identification nameplates and labels for control items in English.

#### **2.2 MATERIALS AND EQUIPMENT**

- .1 Material and equipment to be CSA certified. Where CSA certified material and equipment are not available, obtain special approval from inspection authorities before delivery to site and submit such approval as described in Part 1 - Action and Informational Submittals.
- .2 Factory-assemble control panels and component assemblies.

#### **2.3 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS**

- .1 Verify installation and co-ordination responsibilities related to motors, equipment, and controls, as indicated.

## 2.4 WARNING SIGNS

- .1 Warning Signs: in accordance with requirements of authority having jurisdiction.
- .2 Decal signs, minimum size 175 x 250 mm.

## 2.5 WIRING TERMINATIONS

- .1 Ensure lugs, terminals, screws for termination of wiring are suitable for both copper and aluminum conductors.

## 2.6 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with nameplates as follows:
  - .1 Nameplates:
    - .1 Lamicoid 3 mm thick plastic engraving sheet, black face, white core, mechanically attached with self-tapping screws.

NAMEPLATE SIZES			
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters
  - .2 Labels:
    - .1 Electronically printed, self-adhesive plastic labels with 6 mm high letters unless specified otherwise.
  - .3 Wording on nameplates to be as indicated c/w volts, phase, amps, HP, etc.
  - .4 Allow for average of twenty-five (25) letters per nameplate.
  - .5 Identification to be English and French.
  - .6 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
  - .7 Disconnects, starters and contactors: indicate equipment being controlled and voltage, Size 7.
  - .8 Terminal cabinets and pull boxes: indicate system and voltage, Size 7.
  - .9 Transformers: indicate capacity, primary and secondary voltages, Size 7.
  - .10 Panelboards nameplate, Size 7.
  - .11 Provide typed circuit directory for each panelboard.
  - .12 Identify all receptacle outlets by panel, circuit number and voltage, with Brother P-Touch labeller.
  - .13 Provide identification on service poles and prewired partitions at 300 mm A.F.F.
  - .14 Provide system, circuit, voltage, phase, etc., on all ceiling space junction box covers, red for fire alarm & emergency circuits, black for others.
  - .15 All circuit protective devices to be c/w a lamicoid label mounted inside door of device listing all fuse type and ratings, circuit breaker settings and minimum interrupting ratings.
  - .16 All switchboards and panelboards to have a permanent lamicoid label mounted on inside of door with minimum circuit breaker interrupting rating.

## 2.7 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, coloured plastic tapes on both ends of phase conductors of feeders and branch circuit wiring, respectively.

- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1 and OESC.

## 2.8 CONDUIT AND CABLE IDENTIFICATION

- .1 Colour code conduits, boxes, and metallic sheathed cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
- .3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

	Prime	Auxiliary
up to 250 V	blue	
up to 600 V	yellow	
up to 5 kV	yellow	blue
up to 15 kV	yellow	yellow
Voice/data	green	
Security	green	blue
Fire Alarm	red	
Emergency power (250V)	red	blue
Emergency power (600V)	red	yellow

## 2.9 FINISHES

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
  - .1 Paint outdoor electrical equipment "equipment green" finish to EEMAC Y1-1.
  - .2 Paint indoor distribution enclosures light grey to EEMAC 2Y1.
- .2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .3 Clean and prime exposed non-galvanized or cut ends of galvanized hangers, racks, and fastenings to prevent rusting.

## 2.10 SPRINKLER-PROOF EQUIPMENT

- .1 All equipment to have sprinkler proof drip shields and ventilation openings.

## 2.11 ACCESS DOORS

- .1 Provide access doors as required by inspection authorities and Engineer to ensure access to concealed electrical work.
- .2 Access doors shall have fire resistance rating equal to wall or ceiling in which door to be installed. Minimize access door requirements and obtain approval of locations prior to electrical systems installation. Prepare a sketch drawing indicating locations for review by Owner/Architect/Engineer and submit in accordance with shop drawing submittal.
- .3 Submit access door shop drawings.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- .1 Do complete installation in accordance with CSA C22.1 and OESC except where specified otherwise.
- .2 Do overhead and underground systems in accordance with CAN/CSA C22.3 No.1 except where specified otherwise.

### **3.2 NAMEPLATES AND LABELS**

- .1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

### **3.3 CONDUIT AND CABLE INSTALLATION**

- .1 Install conduit and sleeves prior to pouring of concrete.
  - .1 Sleeves through concrete: sized for free passage of conduit, and protruding 50 mm.
  - .2 Pipe clamp secured to concrete.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

### **3.4 LOCATION OF OUTLETS**

- .1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .2 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes. Provide additional support as required.
- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.
- .4 Locate light switches on latch side of doors, unless otherwise indicated.
- .5 Co-ordinate exact locations, dimensions, and mounting heights with architectural and interior design layouts, and/or millwork details and elevations.

### **3.5 MOUNTING HEIGHTS**

- .1 Mounting height of equipment is from finished floor to centreline 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 following heights unless indicated otherwise. Coordinate all mounting heights with architectural drawings prior rough-ins.
  - .1 Local switches: 1100 mm.
  - .2 Wall receptacles:
    - .1 General: 400 mm.
    - .2 Above top of continuous baseboard heater: minimum 200 mm.
    - .3 Above top of counters or counter splash backs: 175 mm.
    - .4 In mechanical rooms: 1200 mm.
  - .3 Panelboards: as required by Code or as indicated.

- .4 Telephone and interphone outlets: 400 mm.
- .5 Fire alarm stations: 1200 mm.
- .6 'F' indicates floor mounted; 'C' indicates ceiling mounted.
- .4 Wall mounted fire alarm signal and visual devices: minimum 2300 mm and maximum 2400 mm to top of device, or 150 mm below ceiling where ceiling heights do not allow. All in accordance with CAN/ULC S524.

### 3.6 FIELD QUALITY CONTROL

- .1 Conduct following tests in accordance with manufacturer's recommendations and relevant Section 01 45 00 - Quality Control.
  - .1 Distribution system including phasing, voltage, grounding, and load balancing.
  - .2 Lighting and its control.
  - .3 Motors, heaters, and associated control equipment including sequenced operation of systems where applicable.
  - .4 Systems:
    - .1 Fire alarm.
  - .5 Load Balance:
    - .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
    - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
    - .3 Provide upon completion of work, load balance report as directed in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS, phase and neutral currents on panelboards, dry-core transformers, and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .2 Carry out tests in presence of Engineer. Provide minimum 7 days' notice.

### 3.7 SYSTEM START UP

- .1 Instruct Consultant and operating personnel in operation, care and maintenance of systems, system equipment and components.
- .2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance, and calibrate components and instruct operating personnel.
- .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation and ensure that operating personnel are conversant with aspects of its care and operation.

### 3.8 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 reuse and recycling.

- .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.
- .4 Clean areas under contract to a condition at least equal to that previously existing and to approval of Engineer.
- .5 Provide cleaning of light fixture reflectors, lamps and lenses, vacuum and clean panelboards, cabinets switchgear, etc., upon completion of contract, to Engineer's satisfaction.

### **3.9 ANCHORING METHODS**

- .1 Electrical equipment, fixtures, cable tray, conduit, and cabling is to be securely anchored or fastened to the building structure using drilled hole wedge anchors for concrete structures or steel clamps for steel structures.
- .2 Where anchoring method forms part of seismic restraint requirements, anchoring methods to comply with Section 26 05 04 - Seismic Restraint Systems (SRS).

### **3.10 CUTTING, PATCHING & MAKING GOOD**

- .1 Provide cutting & patching of existing surfaces as required to accommodate new work.
- .2 Patch and make good surfaces cut, damaged or disturbed, to Engineer's approval. Match existing material, colour, finish, and texture or as indicated otherwise.
- .3 Provide dust tight screens or partitions to localize dust generating activities and for protection of finished areas of work, workers and public.
- .4 Scan slabs before coring or drilling deeper than 1" (25 mm). Provide all required notification, clearance & protection for scanning process. Adjust coring & drilling locations as necessary to avoid rebar & conduits.

### **3.11 FINAL INSPECTION**

- .1 Do not request final inspection until:
  - .1 All previously noted Deficiencies have been addressed.
  - .2 All systems have been tested and are ready for operation.
  - .3 Preliminary load balancing has been completed.
  - .4 The Owner's operating personnel have been instructed in the operation of all systems and equipment.
  - .5 The complete operation and maintenance data books have been delivered to the Engineer.
  - .6 All inspection certificates have been furnished.
  - .7 All record drawings have been completed and approved.
  - .8 All spare parts and replacement parts have been provided and receipt of same acknowledged.
  - .9 The cleaning up is finished in all respects.
  - .10 Fire alarm verification certificates submitted.
- .2 Final inspection shall be subject to the approval of the Engineer.

### **3.12 FIRE AND SMOKE STOPPING**

- .1 Provide fire and smoke stopping where conduits, cables, trays, etc., penetrate floor slabs or fire rated walls with an approved ULC listed putty, equal to 3M caulk CP25 and putty 303.



- .2 Installation of fire stops by trained manufacturer's representative.

### **3.13 USE OF SITE AND FACILITIES**

- .1 Execute work with least possible interference or disturbance to normal use of premises. Make arrangements with Building Owner to facilitate work as stated.
- .2 Particular attention shall be given to minimizing dust, noise, and other forms of contamination from occupied areas.
- .3 Maintain existing services to building and provide for personnel and vehicle access.
- .4 Existing services required for work may be used by the Contractor with the Owners written consent. Ensure capacity is adequate prior to imposing additional loads. Connect and disconnect at own expense and responsibility.
- .5 Notify the Owner a minimum of 72 hours in advance of intended interruption of services; obtain requisite permissions.
- .6 Keep duration of these interruptions to a minimum. Carry out all interruptions after normal working hours of the occupants, preferably on weekends or as approved by the Owner in writing.
- .7 Any unscheduled disruption to services to be immediately reinstated at contractors' own expense.
- .8 Existing fire alarm and security systems are to remain fully functional, throughout, provide conduit and wire as required to maintain services during construction.
- .9 Where fire alarm protection and security are reduced by work, provide temporary means to maintain fire alarm protection and security.

### **3.14 PROTECTION**

- .1 Protect access areas through existing building (lobby, elevator, corridor stairwell, etc.) from damage. Clean area daily or more frequently if directed by Engineer.
- .2 Protect exterior areas (roof, walls, etc.) against damage during handling of new and removed materials.
- .3 Repair and make good all damaged equipment, etc. to satisfaction of the Engineer.
- .4 Protect stored materials, work in process and finished work against damage until take-over.
- .5 Protect adjacent areas against spread of dust and dirt beyond work areas.
- .6 Protect operatives and other users of site from all hazards.

### **3.15 DEMOLITION**

- .1 Unless otherwise specified, materials for removal become the Contractor's property and shall be taken from site, and disposed of in accordance with all applicable codes, standards, and regulations.
- .2 Existing lighting ballasts may contain P.C.B.'s. Contact the local Ministry of Environment (M.O.E.) office for confirmation of ballasts containing P.C.B. material. Submit written confirmation from M.O.E. verifying the presence or non-presence of P.C.B.'s. If P.C.B.'s are found to be present, provide removal of ballasts from light fixtures and place in approved 45-gallon drums for storage on site. Handle P.C.B. contaminated equipment in accordance with codes, standards, and guidelines.
- .3 Disconnect and make safe all systems to be demolished.
- .4 Maintain and protect existing remaining circuits, systems, etc., which pass through construction/demolition areas.

- .5 Remove all redundant wiring and conduit in ceiling spaces, (power, communications, systems, etc.).

### 3.16 PROGRESS BILLING-ELECTRICAL CONTRACT PRICE \$

.1

Item		Total Contract Amount \$	% to Date	Total to Date \$	Previous Amount Invoiced \$	Amount this Claim \$	Balance Remaining \$
Job Set-up (Mobilization)							
Permits & Inspections							
Site Work							
Short Circuit, Coordination, Arc-Flash Study	Report						
	Implementation						
Distribution	Material						
	Labour						
Branch Circ. Roughing	Material						
	Labour						
Wiring Devices	Material						
	Labour						
Lighting (Interior & Exterior)	Material						
	Labour						
Emergency & Exit Lighting	Material						
	Labour						
Fire Alarm	Material						
	Labour						
Data/ Communications Raceways	Material						
	Labour						
	Material						

Item		Total Contract Amount \$	% to Date	Total to Date \$	Previous Amount Invoiced \$	Amount this Claim \$	Balance Remaining \$	
Generator & Transfer Switches (if applicable)	Labour							
	Start-up							
Systems – Security, Data Communication Cabling, PA System, Nurse Call, Intercom (job specific)	Material							
	Labour							
	Start-up							
	Motor Control (if applicable)	Material						
Labour								
Testing & Verification								
CAN ULC S1001 Integrated Testing								
Job Clean-up (Demobilization)								
As-builts and O&M Manuals								
TOTAL ORIGINAL CONTRACT AMOUNT								
Change Orders								
Architect's CO #	GWAL CCO or SI #							
#	#							
#	#							
Total Change Order Amount								
TOTAL CONTRACT AMOUNT								

NOTE: Change Orders that do not reference the Architect's Change Order number and GWAL, a division of Englobe, Contemplated Change Order (CCO) or Site Instruction (SI) number will not be reviewed.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 RELATED SECTIONS**

- .1 This section shall be read in conjunction with specification Section 26 05 00 - Common Work Results for Electrical, all electrical sections, and all other disciplines related to the project.

### **1.2 GENERAL**

- .1 This section covers design, supply, and installation of complete SRS for all systems, equipment specified for installation on this project by Division 26. This includes, but is not limited to, electrical light fixtures, transformers, MCC's, UPS, diesel generators, fire protection, conduit, communications, electrical equipment, and systems, both vibration isolated and statically supported.
- .2 Cable restraint systems, rod stiffener clamps and seismic isolator capacities to be verified by an independent test laboratory. Connection materials and site-specific designs to be by the Seismic Engineer. The Seismic Engineer may specify material and anchors provided by the contractor where this is appropriate. It is the contractors' responsibility to ensure that the Seismic Engineers' requirements and specification have been met.

### **1.3 DEFINITIONS**

- .1 SRS: acronym for Seismic Restraint System.

### **1.4 GENERAL DESCRIPTION**

- .1 This section covers design, supply and installation of complete SRS for all systems, equipment specified for installation on this project by Division 26. This includes, but is not limited to, electrical light fixtures, transformers, MCC's, UPS, diesel generators, fire protection, conduit, communications, electrical equipment and systems, both vibration isolated and statically supported.
- .2 Cable restraint systems, rod stiffener clamps and seismic isolator capacities to be verified by an independent test laboratory. Connection materials and site-specific designs to be by the Seismic Engineer. The Seismic Engineer may specify material and anchors provided by the contractor where this is appropriate. It is the contractors' responsibility to ensure that the Seismic Engineers' requirements and specification have been met.

### **1.5 REFERENCES**

- .1 Canadian Standards Association (CSA)
  - .1 CSA S832, Seismic Risk Reduction of Operational and Functional Components (OFCs) of Buildings.
- .2 Ontario Regulation
  - .1 ONTARIO OBC, Ontario Building Code.
- .3 National Research Council Canada
  - .1 NRCC NBCC, National Building Code of Canada.

### **1.6 SUBMITTALS**

- .1 Submit shop drawings and product data in accordance with Section 26 05 00 - Common Work Results for Electrical.

- .2 Submit seismic restraint shop drawings, c/w seal of Professional Engineer registered in Province of Ontario, clearly identifying equipment/systems reviewed and the equipment/systems requiring restraint. Shop drawings must clearly show all forces transferred to structure.
- .3 Seismic Design Engineer shall provide a spreadsheet identifying all equipment and systems requiring or not requiring seismic restraints and include all circulations.
- .4 Submit additional copy of shop drawings and product data to project Structural Engineer for review of connection points to building structure.

## **1.7 MAINTENANCE DATA**

- .1 Provide maintenance data including monitoring requirements for incorporation into manuals specified in Section 26 05 00 - Common Work Results for Electrical.

## **1.8 SEISMIC FORCE**

- .1 The Importance Factor for this project is:
  - .1  $I = 1.3$  - Schools.

## **PART 2 PRODUCTS**

### **2.1 SRS MANUFACTURER**

- .1 SRS to be from one manufacturer regularly engaged in production of same, 5 years' experience.
- .2 Acceptable materials: Korfund-Sampson, Mason Industries, Tecoustics, Vibra-Sonic Control, Vibron.

### **2.2 GENERAL**

- .1 Design to be by Professional Engineer specializing in design of SRS and registered in Province of Ontario. Division 26 to include all costs associated with this work as it relates to Division 26 installations.
- .2 SRS to be fully integrated into, compatible with:
  - .1 Noise and vibration controls specified elsewhere in this project specification, telecommunications.
  - .2 Structural, mechanical, electrical design of project.
- .3 During seismic event, SRS to prevent systems and equipment from causing personal injury, interfering with other systems, and from moving from normal position.
- .4 Design and installation in accordance with OBC, NBCC, CSA S832.
- .5 SRS to provide gentle and steady cushioning action and avoid high impact loads
- .6 SRS to restrain seismic forces in all directions.
- .7 Fasteners and attachment points to resist same load as seismic restraints.
- .8 SRS of conduit systems to be compatible with:
  - .1 Expansion, anchoring and guiding requirements.
  - .2 Equipment vibration isolation and equipment SRS.
- .9 SRS utilizing cast iron, threaded pipe, other brittle materials not permitted.
- .10 Attachments to RC structure:
  - .1 Use high strength mechanical expansion anchors.

- .2 Drilled or power-driven anchors not permitted.
- .11 Seismic control measures not to interfere with integrity of firestopping.

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

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

## **2.4 SRS FOR VIBRATION ISOLATED EQUIPMENT**

- .1 Floor mounted equipment, systems:
  - .1 Use one or combination of following methods:
    - .1 Vibration isolators with built-in snubbers.
    - .2 Vibration isolators and separate snubbers.
    - .3 Built-up snubber system approved by Engineer, consisting of structural elements and elastomeric layer.
  - .2 SRS to resist complete isolator unloading.
  - .3 SRS not to jeopardize noise and vibration isolation systems. Provide 4-8 mm clearance between seismic restraint snubbers and equipment during normal operation of equipment and systems.
  - .4 Cushioning action to be gentle and steady by utilizing elastomeric material or other means in order to avoid high impact loads.
- .2 Suspended equipment, systems:
  - .1 Use one or combination of following methods:
    - .1 Slack cable restraint system.
    - .2 Brace back to structure via vibration isolators and snubbers.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- .1 Install Seismic Restraint Systems in accordance with Seismic Engineer's and manufacturer's recommendations.

- .2 Install SRS at least 25 mm from all other equipment, systems, services.
- .3 Co-ordinate connections with all disciplines.

### **3.2 INSPECTION AND CERTIFICATION**

- .1 SRS to be inspected and certified by Manufacturer upon completion of installation.
- .2 Seismic Design Engineer shall provide written report to Engineer certifying that SRS has been installed in accordance with the SRS drawings. The report shall bear the seal and signature of the SRS Design Engineer.

### **3.3 COMMISSIONING DOCUMENTATION**

- .1 Upon completion and acceptance of certification, hand over to Engineer complete set of construction documents, revised to show "as-built" conditions.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 RELATED SECTIONS**

- .1 This section shall be read in conjunction with specification Section 26 05 00 - Common Work Results for Electrical, all electrical sections, and all other disciplines related to the project.

### **1.2 REFERENCES**

- .1 CSA International
  - .1 CSA C22.2 No. 18.4, Hardware for the Support of Conduit, Tubing, and Cable.
  - .2 CAN/CSA C22.2 No. 65, Wire Connectors.
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
  - .1 EEMAC 1Y-2, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
- .3 National Electrical Manufacturers Association (NEMA)

## **PART 2 PRODUCTS**

### **2.1 MATERIALS**

- .1 Pressure type wire connectors to: CAN/CSA C22.2 No. 65, with current carrying parts of copper sized to fit conductors as required.
- .2 Fixture type splicing connectors to: CAN/CSA C22.2 No. 65, with current carrying parts of copper sized to fit copper conductors 10 AWG or less.
- .3 Bushing stud connectors: to EEMAC 1Y-2 & NEMA to consist of:
  - .1 Connector body and stud clamp suitable for application to conductors.
  - .2 Clamp suitable for application to conductors.
  - .3 Stud clamp bolts.
  - .4 Bolts for copper conductors, bar.
  - .5 Sized for conductors and bars as required.
- .4 Clamps or connectors for armoured cable, TECK cable, aluminum sheathed cable, mineral insulated cable, flexible conduit, non-metallic sheathed as required to: CAN/CSA C22.2 No. 18.4.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- .1 Remove insulation carefully from ends of conductors and cables 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 CAN/CSA C22.2 No. 65.
  - .2 Install fixture type connectors and tighten to CAN/CSA C22.2 No. 65. Replace insulating cap.



- .3 Install bushing stud connectors in accordance with EEMAC 1Y-2 and NEMA.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 RELATED SECTIONS**

- .1 This section shall be read in conjunction with specification Section 26 05 00 - Common Work Results for Electrical, all electrical sections, and all other disciplines related to the project.

## **PART 2 PRODUCTS**

### **2.1 BUILDING WIRES**

- .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .2 Copper conductors: size as indicated, with insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE and RWU90 XLPE for all buried services, Jacketed. 600 V rating up to 347 V & 1000 V rating up to 600 V.

### **2.2 ARMoured CABLES**

- .1 Conductors: insulated, copper, size as indicated.
- .2 Type: AC90.
- .3 Armour: interlocking type fabricated from aluminum strip.
- .4 Connectors: anti short connectors.

## **PART 3 EXECUTION**

### **3.1 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform ground & meg ohm, phasing tests using method appropriate to site conditions and to approval of Consultant and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.

### **3.2 GENERAL CABLE INSTALLATION**

- .1 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .2 Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.
- .3 Conductor length for parallel feeders to be identical.
- .4 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .5 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.

### **3.3 INSTALLATION OF BUILDING WIRES**

- .1 Install wiring as follows:
  - .1 In conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

### **3.4 INSTALLATION OF ARMoured CABLES**

- .1 Group cables wherever possible on channels.

- .2 Installation of armoured cables shall be permitted from:
  - .1 Conduit system junction boxes to recessed lighting fixtures in suspended ceilings, maximum length 2.5 m each run.
  - .2 Conduit system junction boxes to hollow gypsum partitions, maximum length 2.5 m each run.
  - .3 AC-90 is permitted in hollow gypsum partitions.
  - .4 AC90 is not permitted in insulated masonry walls or concrete walls.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 RELATED SECTIONS**

- .1 This section shall be read in conjunction with specification Section 26 05 00 - Common Work Results for Electrical, all electrical sections, and all other disciplines related to the project.

## **PART 2 PRODUCTS**

### **2.1 EQUIPMENT**

- .1 Grounding conductors: bare stranded copper, tinned, soft annealed, size in accordance with Authority having Jurisdiction.
- .2 Insulated grounding conductors: green, copper conductors, size in accordance with Authority having Jurisdiction.
- .3 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
  - .1 Grounding and bonding bushings.
  - .2 Protective type clamps.
  - .3 Bolted type conductor connectors.
  - .4 Thermit welded type conductor connectors.
  - .5 Bonding jumpers, straps.
  - .6 Compression wire connectors.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION GENERAL**

- .1 Install connectors in accordance with manufacturer's instructions.
- .2 Protect exposed grounding conductors from mechanical injury.
- .3 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .4 Soldered joints not permitted.
- .5 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.
- .6 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.
- .7 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.
- .8 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.
- .9 Provide ground conductor in all conduits and raceways.
- .10 Ground all systems raceways. Provide ground bushings.

### **3.2 EQUIPMENT GROUNDING**

- .1 Install grounding connections to typical equipment included in but not necessarily limited to following list. Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steel work, generators, elevators and escalators, distribution panels, outdoor lighting, cable trays.

### **3.3 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Engineer and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.
- .4 Disconnect ground fault indicator during tests.

**END OF SECTION**

March 2026

## **PART 1 GENERAL**

### **1.1 RELATED SECTIONS**

- .1 This section shall be read in conjunction with specification Section 26 05 00 - Common Work Results for Electrical, all electrical sections, and all other disciplines related to the project.

## **PART 2 PRODUCTS**

### **2.1 SUPPORT CHANNELS**

- .1 U shape, galvanized, minimum size 41 x 41 mm, 2.5 mm thick or to suit site conditions.

### **2.2 THREADED RODS**

- .1 Galvanized, minimum 9 mm diameter.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- .1 Secure equipment to masonry, tile and plaster surfaces with lead anchors or nylon shields or toggle bolts.
- .2 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .3 Fasten exposed conduit or cables to building construction or support system using straps.
  - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
  - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
  - .3 Beam clamps to secure conduit to exposed steel work.
- .4 Suspended support systems.
  - .1 Support individual cable or conduit runs with 9 mm diameter threaded rods and spring clips.
  - .2 Support 2 or more cables or conduits on channels supported by 9 mm diameter threaded rod hangers where direct fastening to building construction is impractical.
- .5 For surface mounting of two or more conduits use channels.
- .6 Provide metal brackets, frames, hangers, clamps, and related types of support structures where indicated or as required to support conduit and cable runs.
- .7 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .8 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .9 Do not use supports or equipment installed for other trades for conduit or cable support.
- .10 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.
- .11 Complete installation in accordance with Section 26 05 04 - Seismic Restraint Systems (SRS).

**END OF SECTION**

March 2026

## **PART 1 GENERAL**

### **1.1 RELATED SECTIONS**

- .1 This section shall be read in conjunction with specification Section 26 05 00 - Common Work Results for Electrical, all electrical sections, and all other disciplines related to the project.

### **1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations

## **PART 2 PRODUCTS**

### **2.1 JUNCTION AND PULL BOXES**

- .1 Construction: welded steel enclosure.
- .2 Covers Flush Mounted: 25 mm minimum extension all around.
- .3 Covers Surface Mounted: screw-on covers.

## **PART 3 EXECUTION**

### **3.1 JUNCTION, PULL BOXES AND CABINETS INSTALLATION**

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Install junction and pull boxes as indicated. Provide additional pull boxes in accordance with CSA C22.1.

### **3.2 IDENTIFICATION**

- .1 Equipment Identification: to Section 26 05 00 - Common Work Results for Electrical.
- .2 Identification Labels: size 2 indicating system name, voltage, and phase.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 RELATED SECTIONS**

- .1 This section shall be read in conjunction with specification Section 26 05 00 - Common Work Results for Electrical, all electrical sections, and all other disciplines related to the project.

### **1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.

## **PART 2 PRODUCTS**

### **2.1 OUTLET AND CONDUIT BOXES GENERAL**

- .1 Size boxes in accordance with CSA C22.1.
- .2 102 mm square or larger outlet boxes as required.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 347 V outlet boxes for 347 V switching devices.
- .6 Combination boxes with barriers where outlets for more than one system are grouped.

### **2.2 GALVANIZED STEEL OUTLET BOXES**

- .1 One-piece electro-galvanized construction.
- .2 Single and multi-gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .3 Utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.
- .4 102 mm square or octagonal outlet boxes for lighting fixture outlets.
- .5 Extension and plaster rings for flush mounting devices in finished walls.

### **2.3 CONDUIT BOXES**

- .1 Cast FS boxes with factory-threaded hubs and mounting feet for surface wiring of devices.

### **2.4 FITTINGS - GENERAL**

- .1 Plastic bushing or connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of debris.
- .3 Conduit outlet boxes for conduit up to 35mm and pull boxes for larger conduits.
- .4 Locknuts and insulated bushings on sheet metal boxes.



---

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- .1 Support boxes independently of connecting conduits.
- .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- .3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Do not install reducing washers.
- .5 Vacuum clean interior of outlet boxes before installation of wiring devices.
- .6 Identify systems for outlet boxes as required.

**END OF SECTION**

March 2026

## **PART 1 GENERAL**

### **1.1 RELATED SECTIONS**

- .1 This section shall be read in conjunction with specification Section 26 05 00 - Common Work Results for Electrical, all electrical sections, and all other disciplines related to the project.

### **1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CAN/CSA C22.2 No. 18.3 Conduit, Tubing, and Cable Fittings.
  - .2 CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .3 CSA C22.2 No. 83, Electrical Metallic Tubing.

## **PART 2 PRODUCTS**

### **2.1 CONDUITS**

- .1 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.
- .2 Flexible metal conduit: to CSA C22.2 No. 56, steel and liquid-tight flexible metal.

### **2.2 CONDUIT FASTENINGS**

- .1 One hole steel straps to secure surface conduits 50 mm and smaller.
  - .1 Two-hole steel straps for conduits larger than 50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits in accordance with Authority Having Jurisdiction.
- .4 Threaded rods, minimum 6 mm diameter, to support suspended channels. Galvanized in damp or wet locations.

### **2.3 CONDUIT FITTINGS**

- .1 Fittings: to CAN/CSA C22.2 No. 18.3, manufactured for use with conduit specified. Coating: same as conduit.
- .2 Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.
- .3 Steel set-screw connectors and couplings for EMT.

### **2.4 FISH CORD**

- .1 Polypropylene.

## **PART 3 EXECUTION**

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

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

March 2026

### **3.2 INSTALLATION**

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas, unless otherwise noted.
- .3 Use electrical metallic tubing (EMT) except in cast concrete, unless otherwise noted.
- .4 Use flexible metal conduit for connection to motors in dry areas, connection to light fixtures, work in movable metal partitions.
- .5 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .6 Minimum conduit size for lighting and power circuits: 21 mm.
- .7 Bend conduit cold:
  - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .8 Mechanically bend steel conduit over 21 mm diameter.
- .9 Install fish cord in empty conduits.
- .10 Remove and replace blocked conduit sections.
  - .1 Do not use liquids to clean out conduits.
- .11 Dry conduits out before installing wire.
- .12 Maintain maximum spacing between power and low-voltage communications conduits.
- .13 Do not use supports or equipment of other trades to support conduit or cable except with permission of other trades and approval of Engineer.
- .14 Ream raceways to remove burrs.
- .15 Run parallel or perpendicular to building lines.
- .16 Do not install horizontal runs in masonry walls.
- .17 Do not install conduits in terrazzo or concrete toppings.
- .18 Provide Unistrut assembly independently anchored to building structure for support of conduits.

### **3.3 SURFACE CONDUITS**

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 RELATED SECTIONS**

- .1 This section shall be read in conjunction with specification Section 26 05 00 - Common Work Results for Electrical, all electrical sections, and all other disciplines related to the project.

### **1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International) / National Standard of Canada
- .2 Underwriters Laboratories
  - .1 UL 248-12, Low-Voltage Fuses - Part 12: Class R Fuses.

### **1.3 ACCEPTABLE MANUFACTURERS**

- .1 Eaton Cutler/Hammer.
- .2 Siemens.
- .3 Schneider/Square D.
- .4 G.E.
- .5 Equipment supplied shall be of a single manufacturer.

### **1.4 RATINGS**

- .1 Equipment supplied shall have interrupting capacities in excess of currents calculated in the short circuit study.

### **1.5 OVERCURRENT PROTECTION**

- .1 Confirm overcurrent protection requirements of equipment supplied by Divisions 20, 21, 22 & 23, Architectural Divisions and equipment supplied by Owner prior to installation.

## **PART 2 PRODUCTS**

### **2.1 DISCONNECT SWITCHES**

- .1 Heavy duty fusible and non-fusible, disconnect switch in CSA Enclosure I, size as indicated. CSA 3 Enclosure in outdoor or damp locations. Arc quencher and visible blade copper terminals.
- .2 Provision for padlocking in on-off switch position.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as indicated.
- .5 Quick make, quick break type.

### **2.2 PANELBOARDS**

- .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.
- .3 250 and 600 V panelboards: bus and breakers rated for interrupting capacity as indicated in coordination study.

- .4 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.
- .5 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated. Copper bus.
- .6 Two keys for each panelboard and key panelboards alike.
- .7 Mains: suitable for bolt-on breakers, copper.
- .8 Panel must be capable of accepting 3 pole breakers anywhere in panel.
- .9 Trim with concealed front bolts and hinges. 14 gauge up to 24 circuit, 12 gauge for larger panels.
- .10 Distribution panels shall be minimum 12-gauge construction.

### **2.3 MOULDED CASE CIRCUIT BREAKERS**

- .1 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient.
- .2 Common-trip breakers: with single handle for multi-pole applications.
- .3 Circuit breakers with interchangeable trips as indicated.
- .4 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

### **2.4 FUSES**

- .1 Fuse type references L1, L2, J1, R1 etc. have been adopted for use in this specification.
- .2 Fuses: product of one manufacturer.
- .3 HRC-L fuses (formerly Class L).
  - .1 Type L1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
  - .2 Type L2, fast acting.
- .4 HRCI-J fuses (formerly Class J).
  - .1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
  - .2 Type J2, fast acting.
- .5 HRCI-R fuses (formerly Class R). For UL 1 fuses, peak let-through current and  $I^2t$  values not to exceed limits of UL 248-12, table 10.2.
  - .1 Type R1, (UL 1), time delay, capable of carrying 500% of its rated current for 10 s minimum, to meet UL 1 maximum let-through limits.
  - .2 Type R2, time delay, capable of carrying 500% of its rated current for 10 s minimum.
  - .3 Type R3, (UL 1), fast acting Class R, to meet UL 1 maximum let-through limits.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- .1 Confirm equipment locations and sizes in electrical and mechanical rooms to ensure equipment will fit.
- .2 Secure floor and wall mounted equipment plumb and square.
- .3 Connect supply and load feeders from all equipment.

- .4 Check trip unit and fuse ratings to match those recommended in coordination study.
- .5 Check factory made connections for secureness and electrical continuity.
- .6 Install fuses as required.
- .7 Ensure adequate clearances around equipment for ventilation requirements and code.
- .8 Provide auxiliary equipment and connections as required.
- .9 Provide typed, dated panel directory for each affected panelboard on this project.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 RELATED SECTIONS**

- .1 This section shall be read in conjunction with specification Section 26 05 00 - Common Work Results for Electrical, all electrical sections, and all other disciplines related to the project.

### **1.2 EQUIPMENT**

- .1 Receptacle and switch devices shall be of a single manufacturer.

### **1.3 REFERENCES**

- .1 Canadian Standards Association (CSA)
  - .1 CSA C22.2 No. 42, General Use Receptacles, Attachment Plugs, and Similar Wiring Devices.
  - .2 CSA C22.2 No. 55, Special Use Switches.
  - .3 CSA C22.2 No. 111:25, General-use snap switches.
  - .4 CSA C22.2 No. 126.1, Metal cable tray systems.

## **PART 2 PRODUCTS**

### **2.1 SWITCHES**

- .1 15 and 20 A, 120 V and 347 V, single pole, double pole, three-way, four-way switches to: CSA C22.2 No.55 and CSA C22.2 No.111.
- .2 Manually operated general purpose ac switches with following features:
  - .1 Terminal holes approved for No. 10 AWG wire.
  - .2 Silver alloy contacts.
  - .3 Urea or melamine molding for parts subject to carbon tracking.
  - .4 Suitable for back and side wiring.
  - .5 White toggle.
- .3 Switches of one manufacturer throughout project.

### **2.2 RECEPTACLES**

- .1 Duplex receptacles, CSA type 5-15 R / 5-20R, 125 V, 15 A / 20A, U ground, to: CSA C22.2 No.42 with following features:
  - .1 White urea molded housing.
  - .2 Suitable for No. 10 AWG for back and side wiring.
  - .3 Break-off links for use as split receptacles.
  - .4 Eight back wired entrances, four side wiring screws.
  - .5 Triple wipe contacts and riveted grounding contacts.
  - .6 Ground fault interrupter 5 mA, Class 'A' type where indicated.
  - .7 Other receptacles with ampacity and voltage as indicated.

- .8 Receptacles of one manufacturer throughout project.

## **2.3 SPECIAL WIRING DEVICES**

- .1 Wall mounted occupancy sensor switches: Dual technology, passive infrared and ultrasonic to turn lights off after adjustable time delay. Tamperproof for programming manual "on" and automatic "off" at 5-30 minutes delay. Automatically adjusts time delay for usage pattern. Automatic audible/visual alerts/light sensor with adjustable sensitivity, vandal resistant lens. Operating voltage: 120 VAC, 60 Hz and/or low voltage 24VDC; high sensitivity; load 0-1500W LED.
- .2 Ceiling mounted occupancy sensor: Dual technology passive infrared and ultrasonic to turn lights off after adjustable time delay (5-30 minutes). Operating voltage: 120 VAC, 60 Hz and/or low voltage 24VDC; high sensitivity; load 0-1500W LED. 1/6HP motor load.
- .3 Special wiring devices of one manufacturer throughout project.

## **2.4 DIMMER SWITCHES**

- .1 Wall mounted 0-10V and/or ELV dimmer switch that is compatible with new LED lighting fixtures.
- .2 Dimmer switches of one manufacturer throughout project.

## **2.5 COVER PLATES**

- .1 Cover plates for wiring devices to: CAN/CSA C22.2 No. 126.1.
- .2 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .3 Stainless steel, vertically brushed, 1 mm thick cover plates for wiring devices mounted in flush-mounted outlet box.
- .4 Cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .5 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.
- .6 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.

## **2.6 TELEPHONE, DATA & CABLE TV OUTLET**

- .1 Provide 100 x 100 mm outlet box c/w plaster ring and 21 mm EMT to accessible ceiling space at indicated locations.
- .2 Coverplates to be provided by respective companies or as specified in other sections.

# **PART 3 EXECUTION**

## **3.1 INSTALLATION**

- .1 Switches:
  - .1 Install single throw switches with handle in "UP" position when switch closed.
  - .2 Install switches in gang type outlet box when more than one switch is required in one location.
  - .3 Mount toggle switches at height specified in Section 26 05 00 - Common Work Results for Electrical or as indicated.



- .2 Receptacles:
  - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
  - .2 Mount receptacles at height specified in Section 26 05 00 - Common Work Results for Electrical or as indicated.
  - .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
- .3 Special wiring devices:
  - .1 Set motion sensor programming switches for manual ON/OFF, 15 minutes time delay off, light sensitivity to midrange, SmartSet on. Walk-thru mode on, audible alert on.
  - .2 Provide minimum 3 hours manufacturer training for typical set up.
- .4 Coverplates:
  - .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 coverplates meant for flush outlet boxes on surface-mounted boxes.
- .5 Provide weatherproof devices as indicated.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 RELATED SECTIONS**

- .1 This section shall be read in conjunction with specification Section 26 05 00 - Common Work Results for Electrical, all electrical sections, and all other disciplines related to the project.

### **1.2 REFERENCES**

- .1 International Electrotechnical Commission (IEC).
  - .1 IEC 947-4-1, Part 4-1: Electromechanical Contactors and Motor-starters.

### **1.3 RELATED WORK**

- .1 Refer to shop drawings of other divisions, especially Div. 20, 21, 22, 23 & 25 for exact characteristics of loads to be controlled. Notify Engineer of any changes prior to installation. Ensure starters are suitable for load to be controlled.
- .2 Coordinate with Div. 20, 21, 22, 23 & 25 for control function requirements of the building automation system, and/or monitoring functions. Notify engineer of any discrepancies in requirements.

### **1.4 ACCEPTABLE MANUFACTURERS**

- .1 Motor starters, controls and centres to be of a single manufacturer.

## **PART 2 PRODUCTS**

### **2.1 MATERIALS**

- .1 Starters: to IEC 947-4 with AC4 utilization category. Half sized starters not acceptable.

### **2.2 MANUAL MOTOR STARTERS**

- .1 Single or 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 heaters, manual reset, trip indicating handle.
  - .3 CSA certified as a disconnecting means.
- .2 Accessories:
  - .1 Toggle or H.O.A. switch heavy duty oil tight labelled as indicated.
  - .2 Indicating light: heavy duty oil tight type and colour as indicated.
  - .3 Locking tab to permit padlocking in "ON" or "OFF" position.
  - .4 Keyed where indicated.
- .3 All starters in common areas to be flush mounted. Surface mount in services 1200 MS.

### **2.3 FINISHES**

- .1 Apply finishes to enclosure in accordance with Section 26 05 00 - Common Work Results for Electrical.

## **2.4 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.

## **2.5 REMOTE CONTROL STATIONS**

- .1 Heavy duty type c/w pilot lights and labels, in flush box c/w coverplate.

# **PART 3 EXECUTION**

## **3.1 INSTALLATION**

- .1 Install starters, connect power and control wiring as required.
- .2 Ensure correct fuses and overload devices elements installed.

## **3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical and manufacturer's instructions.
- .2 Operate switches, 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 Submit the following information for each motor controlled, with manuals:
  - .1 Motor nameplate date and manufacturer.
  - .2 Actual measured full load current.
  - .3 Overload device, rating and setting.
- .6 Verify motor rotation prior to acceptance.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 RELATED SECTIONS**

- .1 This section shall be read in conjunction with specification Section 26 05 00 - Common Work Results for Electrical, all electrical sections, and all other disciplines related to the project.

### **1.2 REFERENCES**

- .1 Canadian Standards Association (CSA).
- .2 Underwriters Laboratories
  - .1 UL 1310, UL Standard for Safety Class 2 Power Units - Seventh Edition.
- .3 Underwriters Laboratories of Canada (ULC)

## **PART 2 PRODUCTS**

### **2.1 LED FIXTURES**

- .1 Except as otherwise indicated, provide LED luminaires, of type and size indicated on fixture schedules.
- .2 Including the following features unless otherwise indicated:
  - .1 Each luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply).
  - .2 Each luminaire shall be rated for a minimum operational life of 50,000 hours utilizing a maximum ambient temperature of (25°C).
  - .3 Light Emitting Diodes tested under LM-80 standards for a minimum 12,000 hours.
  - .4 Colour Rendering Index (CRI) of 80 at a minimum.
  - .5 Colour temperature as per fixture schedule
  - .6 Rated lumen maintenance at 70% lumen output for 50,000 hours, unless otherwise indicated.
  - .7 5-year luminaire warranty, minimum.

### **2.2 DRIVERS**

- .1 Electronic driver for LED fixtures: Comply with UL 1310 Class 2 requirements for dry and damp locations. Include the following features unless otherwise indicated:
  - .1 Rated for 50,000 hours of life or greater, unless otherwise noted.
  - .2 Sound rating: Class A.
  - .3 Total Harmonic Distortion Rating: 20 percent or less.
  - .4 Current Crest Factor: 1.5 or less.
  - .5 0-10V dimming standard.

### **2.3 FINISHES**

- .1 Light fixture finish and construction to meet ULC listing s and CSA certification related to intended installation.

## **2.4 LUMINAIRES**

- .1 As indicated in lighting fixture schedule.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- .1 Locate and install luminaires as indicated.
- .2 Provide sufficient cable length and/or access panels, to provide access to wiring connections in hard ceiling areas, to the inspection authorities requirements.
- .3 Install light fixtures to manufacturers recommendations.
- .4 Verify and coordinate location of light fixtures on site with other trades to verify clearances at indicated locations prior to installation.

### **3.2 LUMINAIRE SUPPORTS**

- .1 For recessed or surface mounted lighting in suspended ceiling installations, support luminaires independently from ceiling, by means of a minimum of two chain hangers bolted to diagonal corners of the fixture body and secured to building structure in accordance with ESA, Section 26 05 00 - Common Work Results for Electrical and Section 26 05 04 - Seismic Restraint Systems (SRS).

### **3.3 LUMINAIRE ALIGNMENT**

- .1 Align luminaires mounted in continuous rows to form straight uninterrupted line.
- .2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

### **3.4 TESTING**

- .1 Verify operation of lighting systems, and controls.

**END OF SECTION**

March 2026

## **PART 1 GENERAL**

### **1.1 REFERENCE STANDARDS**

- .1 National Research Council Canada (NRC)
  - .1 NRCC NBCC, National Building Code of Canada.
- .2 Treasury Board of Canada (TBS), Occupational Safety and Health (OSH)
  - .1 Fire Protection Standard-10.
- .3 Underwriter's Laboratories of Canada (ULC)
  - .1 CAN/ULC-S524, Standard for the Installation of Fire Alarm Systems.
  - .2 CAN/ULC-S525, Audible Signal Devices for Fire Alarm Systems, Including Accessories.
  - .3 CAN/ULC-S526, Visual Signal Devices for Fire Alarm Systems.
  - .4 CAN/ULC-S527, Standard for Control Units for Fire Alarm Systems.
  - .5 CAN/ULC-S528, Manual Pull Stations for Fire Alarm Systems.
  - .6 CAN/ULC-S529, Smoke Detectors for Fire Alarm Systems.
  - .7 CAN/ULC-S530, Heat Actuated Fire Detectors.
  - .8 CAN/ULC-S531, Standard for Smoke Alarms.
  - .9 CAN/ULC-S536, Inspection and Testing of Fire Alarm Systems.
  - .10 CAN/ULC-S537, Verification of Fire Alarm Systems.
  - .11 ULC CAN/ULC 541, Speakers for Fire Alarm and Signaling Systems, Including Accessories.

### **1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for multiplex fire alarm system and voice communication systems and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Indicate on shop drawings:
    - .1 Detail assembly and internal wiring diagrams for control units, Consoles, and Auxiliary cabinets.
    - .2 Overall system riser wiring diagram identifying control equipment, initiating zones, and signaling circuits; identifying terminations, terminal numbers, conductors and raceways.
    - .3 Details for devices.
    - .4 Details and performance specifications for control, annunciation and peripherals with item-by-item cross reference to specification for compliance.
    - .5 Step-by-step operating sequence, cross referenced to logic flow diagram.
    - .6 Battery calculations.

March 2026

### 1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for fire alarm and voice communication systems for incorporation into manual.
- .3 Include:
  - .1 Instructions for complete fire alarm system to permit effective operation and maintenance.
  - .2 Technical data - illustrated parts lists with parts catalogue numbers.
  - .3 Copy of approved shop drawings with corrections completed and marks removed except review stamps.
  - .4 List of recommended spare parts for system.

### 1.4 MAINTENANCE MATERIAL SUBMITTALS

- .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

### 1.5 QUALITY ASSURANCE

- .1 Inspection tests to conform to: CAN/ULC-S536.
- .2 Verification tests to conform to: CAN/ULC-S537.
- .3 Submit inspection report, to Consultant.

## PART 2 PRODUCTS

### 2.1 DESCRIPTION

- .1 Fully supervised, microprocessor-based, fire alarm and voice communication system, utilizing digital techniques for data control and digital, and multiplexing techniques for data transmission.
- .2 System to carry out fire alarm and protection functions; including receiving alarm signals; initiating general alarm; supervising components and wiring; actuating annunciators and auxiliary functions; initiating trouble signals and signalling to monitoring agency.
- .3 Zoned, addressable.
- .4 Modular in design to allow for future expansion.
- .5 Operation of system shall not require personnel with special computer skills.
- .6 System to include:
  - .1 Central Control Unit in separate enclosure with power supply, stand-by batteries, central processor with microprocessor and logic interface, main system memory, input-output interfaces for alarm receiving, annunciation/display, and program control/signalling; master telephone with necessary switches and controls.
  - .2 Data Gathering Panels/Transponders with stand-alone capabilities.
  - .3 Power supplies.
  - .4 Initiating/input data loops.
  - .5 Output circuits.
  - .6 Telephone circuits.
  - .7 Auxiliary circuits.

March 2026

- .8 Amplifiers.
- .9 Wiring.
- .10 Manual and automatic initiating devices.
- .11 Audible and visual signalling devices with voice reproducing capability.
- .12 Emergency telephones.
- .13 End-of-line resistors.
- .14 Historic event recorder.
- .7 Equipment and devices: ULC listed and labelled and supplied by single manufacturer
- .8 Power supply: to CAN/ULC-S524
- .9 Audible signal devices: to CAN/ULC-S525
- .10 Control unit: to CAN/ULC-S527
- .11 Manual pull stations: to CAN/ULC-S528
- .12 Thermal detectors: to CAN/ULC-S530
- .13 Smoke detectors: to CAN/ULC-S529
- .14 Smoke alarms: to CAN/ULC-S531
- .15 Horns: to CAN/ULC-S541
- .16 Regulatory requirements:
  - .1 System components: listed by ULC and comply with provisions of applicable Building Code and meet requirements of local authority having jurisdiction.

## **2.2 SYSTEM OPERATION: SINGLE STAGE - SIGNALS ONLY**

- .1 Actuation of alarm initiating device to:
  - .1 Cause electronic latch to lock-in alarm state at central control unit and data gathering panel/transponder as per local fire authority.
  - .2 Indicate zone of alarm at central control unit and remote annunciator.
  - .3 Cause audible signalling devices to sound continuously throughout building and at central control unit.
  - .4 Transmit signal to central monitoring facility.
  - .5 Cause relays to activate in accordance with design and sequence of operations.
- .2 Acknowledging alarm: indicated at central control unit.
- .3 Ensure that it is possible to silence signals by "alarm silence" switch at control unit, after silencing inhibit timer has timed out.
- .4 Subsequent alarm, received after previous alarm has been silenced, to re-activate signals.
- .5 Actuation of supervisory devices to:
  - .1 Cause electronic latch to lock-in supervisory state at central control unit and data gathering panel/transponder.
  - .2 Indicate respective supervisory zone at central control unit and at remote annunciator.
  - .3 Cause audible signal at central control unit to sound.
  - .4 Activate common supervisory sequence.



March 2026

- .6 Resetting devices shall not return system indications/functions back to normal until control unit has been reset.
- .7 Trouble on system to:
  - .1 Indicate circuit in trouble at central control unit.
  - .2 Activate "system trouble" indication, buzzer and common trouble sequence. Acknowledging trouble condition to silence audible indication; whereas visual indication to remain until trouble is cleared and system is back to normal.
- .8 Trouble on system to be suppressed during course of alarm.
- .9 Trouble condition on any circuit in system not to initiate any alarm conditions.

## **2.3 SYSTEM OPERATION: VOICE COMMUNICATION - SINGLE STAGE - SINGLE CHANNEL**

- .1 Actuation of any alarm initiating device to:
  - .1 Cause electronic latch to lock-in alarm state at central control unit and data gathering panel/transponder as per local fire authority.
  - .2 Indicate zone of alarm at central control unit and remote annunciator.
    - .1 Cause speakers to sound evacuation tone throughout building.
    - .2 Transmit signal to central monitoring facility.
    - .3 Cause relays to activate in accordance with design and sequence of operations.
- .2 Possible to transmit voice message from central control unit after evacuation tone has sounded for minimum of 60 seconds. Activating push-to-talk switch on master microphone to silence tones and allow one-way voice messages over system speakers. Releasing microphone switch to re-activate tones on speakers.
- .3 Acknowledging alarm: indicated at central control unit.
- .4 Possible to silence tones by "alarm silence" switch at control unit, after silencing inhibit timer has timed out.
- .5 Subsequent alarm, received after previous alarm has been silenced, to re-activate tones on speakers.
- .6 Actuation of any supervisory device to:
  - .1 Cause electronic latch to lock-in supervisory state at central control unit and data gathering panel/transponder.
  - .2 Indicate respective supervisory zone at central control unit and remote annunciator.
  - .3 Cause audible signal at central control unit to sound.
  - .4 Activate common supervisory sequence.
- .7 Resetting devices shall not return system indications/functions back to normal until control unit has been reset.
- .8 Trouble on system to:
  - .1 Indicate circuit in trouble on central control unit.
  - .2 Activate "system trouble" indication, buzzer and common trouble sequence. Acknowledging trouble condition to silence audible indication; visual indication to remain until trouble is cleared and system is back to normal.
- .9 Trouble on system to be suppressed during course of alarm.
- .10 Trouble condition on any circuit in system not to initiate alarm conditions.

March 2026

## 2.4 CONTROL PANEL

- .1 Central control unit (CCU):
  - .1 Suitable for DCLA communication style: to CAN/ULC-S524. Minimum of two loops per floor and one spare loop.
  - .2 Features specified are minimum requirements for microprocessor-based system with digital data control and digital multiplexing techniques for data transmission.
  - .3 Minimum capacity of 250 addressable monitoring and 250 addressable control/signal points. Points may be divided between 2 communication channels in distributed system, each channel operating independently of other. Faults on one communication channel not to affect operation of other.
  - .4 System to provide for priority reporting levels, with fire alarm points assigned highest priority, supervisory and monitoring lower priority, and third priority for troubles. Possible to assign control priorities to control points in system to guarantee operation or allow emergency override as required.
  - .5 Integral power supply, battery charger and standby batteries.
  - .6 Basic life safety software: retained in non volatile Erasable Programmable Read-Only-Memory (EPROM). Extra memory chips: easily field-installed. Random-Access-Memory (RAM) chips in panel to facilitate password-protected field editing of simple software functions (i.e. zone labels, priorities) and changing of system operation software.
  - .7 Circuitry to continuously monitor communications and data processing cycles of microprocessor. Upon failure, audible and visual trouble indication to activate.
  - .8 Communication between CCU and remote DGP's/TPR's to be supervised, DCLA. Communications failure between CCU and remote units, audible and visual trouble to be indicated at CCU. Data communication to be binary DC, baseband, time-division multiplex, half-duplex. Each data channel: capable of communicating up to distance of 3,000 m.
    - .1 Communication between nodes in networked system to be supervised, DCLA. Communication failure between any 2 nodes, other nodes on loop to continue to communicate with each other and programmed functions on communicating nodes to continue operating.
  - .9 Support up to 4 RS-232-C I/O ports. CCU output: parallel ASCII with adjustable baud rates to allow interface of any commercially available printer, terminal or PC.
  - .10 Equipped with software routines to provide Event-Initiated-Programs (EIP); change in status of one or more monitor points, may be programmed to operate any or all of system's control points.
  - .11 Software and hardware to maintain time of day, day of week, day of month, month and year.
  - .12 On-board, 20-column, DC strip printer, thermal head with automatic paper take-up, and silent operation; operational while system is operating on standby power. Expanded font available for selected printing conditions.
  - .13 Software to operate variable-sensitivity addressable smoke detectors and annunciate their status and sensitivity settings at control panel.
- .2 One way voice communication system.
  - .1 ULC listed for use with fire alarm system. Provide intelligible, low-level, voice reproduction and incorporate one-way voice communication to speaker circuits in building.

March 2026

- .2 Integrated dual channel system for use in fire alarm and emergency paging. Capability to sound either alert/alarm tone or voice message to whole building or parts.
- .3 Manual control of building speaker circuits: via dedicated speaker circuit toggle switches at control panel.
- .4 Master telephone: housed in CCU, push-to-talk, dynamic, noise-cancelling type, with frequency response of 200 to 4000 Hz. Any automatic alarm tone on system may be overridden (after initial inhibit period) by master microphone. Using microphone to enable authorized personnel to broadcast voice messages over system speakers. When such voice messages are completed, system to revert to previous state unless reset or manually controlled by authorized personnel.
- .3 Two-way voice communication system.
  - .1 Two-way voice communication to each floor or zone: via Emergency Telephones. Master telephone and power supply: housed in central control panel, c/w flexible, coiled, self-winding, 1.5 m extension cord.
  - .2 Manual selection of telephone circuits on area-by-area basis. Each telephone circuit to have own selection switch at control panel. Incoming call from remote telephone to activate call-in signal and flash circuit status indicator. Lifting master handset and operating circuit selector switch to illuminate circuit status indicator steady, and connect circuit to telephone voice channel, selected by microprocessor at control panel. Subsequent call-ins: indicated with flashing indicator at control panel, connected after their circuit selector switch is activated.

## 2.5 DATA GATHERING PANELS (DGP'S)/ TRANSPONDERS

- .1 Fire control modules: distributed throughout building in separately enclosed units (DGP'S) and interconnected to central control unit utilizing multiplex data transmission techniques.
- .2 Modules: concentrated in single central location in modular central control panel.
- .3 Fire alarm integrated DGP's: microprocessor based, provide interface between standard alarm input/output devices and central control unit.
- .4 Each DGP: circuitry with ability to detect failure in communication with CCU resulting from faults in communication wiring. In event of loss of communication with CCU, DGP capable of operating in stand-alone mode. In this mode, DGP capable of reacting to connected input devices, and apply stand-alone programming to determine state of connected outputs.
  - .1 Stand-alone programming instructions: independent of, but capable of executing same type of algorithms as, that of CCU.
- .5 Each DGP: self-contained unit, with integral power supply, battery charger and standby batteries. Short circuit, over voltage, and brown-out monitoring to protect powered components by automatically switching to standby batteries whenever trouble condition exists in power supply.
- .6 Addressable DGP's:
  - .1 DGP's: addressable type, provide two-way data communication with addressable devices/interface modules, utilizing digital poll/response protocol communication format. Each addressable device: uniquely identified by own address, set at time of installation.
  - .2 Addressable DGP's: stand-alone capability.
  - .3 Interface modules: facilitate connection of non-addressable devices (i.e. flow switch) to addressable DGP; provided in different types for connection to monitoring devices (i.e. flow/tamper switch), signalling devices (i.e. bells, horns, speakers), and control functions (i.e. fan shutdown, door release); communicate with addressable DGP over minimum number of wires (specified by manufacturer).

March 2026

- .4 Possible to connect all 3 types of addressable interface modules (monitoring, signal and control) to same addressable communication loop.
- .5 Addressable DGP's: self-contained, as specified.
- .6 Possible to connect variable-sensitivity addressable smoke detectors together with other addressable devices to same addressable communication loop.

## **2.6 POWER SUPPLIES**

- .1 120 V, 60 Hz as primary source of power for system.
- .2 Voltage regulated, current limited distributed system power.
- .3 Primary power failure or power loss (less than 102 V) will activate common trouble sequence.
- .4 Interface with battery charger and battery to provide uninterruptible transfer of power to standby source during primary power failure or loss.
- .5 During normal operating conditions fault in battery charging circuit, short or open in battery leads to activate common trouble sequence and standby power trouble indicator.
- .6 Standby batteries: sealed, maintenance free.
- .7 Continuous supervision of wiring for external initiating and alarm circuits to be maintained during power failure.

## **2.7 INITIATING/ INPUT CIRCUITS**

- .1 Receiving circuits for alarm initiating devices such as manual pull stations, smoke detectors, heat detectors and water flow switches, wired in DCLA configuration to nearest control unit.
- .2 Alarm receiving circuits (active and spare): compatible with smoke detectors and open contact devices.
- .3 Actuation of alarm initiating device: cause system to operate as specified in "System Operation".
- .4 Receiving circuits for supervisory, N/O devices. Devices: wired in DCLA configuration to nearest control unit.
- .5 Actuation of supervisory initiating device: cause system to operate as specified in "System Operation".

## **2.8 ALARM OUTPUT CIRCUITS**

- .1 Alarm output circuit: connected to speakers, wired in Class B configuration to nearest control unit.
  - .1 Signal circuits' operation to follow system programming; capable of sounding speakers. Each signal circuit: rated at minimum 2 A, 24 V DC; fuse-protected from overloading/overcurrent.
  - .2 Manual alarm silence, automatic alarm silence and alarm silence inhibit to be provided by system's common control.
  - .3 Speaker circuits operation: follow system programming; capable of reproducing tones and voice fed by audio channels.
  - .4 Audio channel available to each speaker circuit to be automatically and dynamically selected by system's microprocessor.
  - .5 Manual selection and operation of alarm tones to be provided on area-by-area basis.
  - .6 Manual selection for emergency paging to be provided on area-by-area basis.

March 2026

- .7 Proprietary evacuation control switch to be provided to shunt out automatic system programming once manual control of system has been assumed by authorized personnel.
- .2 Alarm output circuits for residential suites shall be wired in Class A configuration to nearest control unit.

## **2.9 AUXILIARY CIRCUITS**

- .1 Auxiliary contacts for control functions.
- .2 Actual status indication (positive feedback) from controlled device.
- .3 Alarm and or supervisory and or trouble on system to cause operation of programmed auxiliary output circuits.
- .4 Two sets of separate contacts for elevator capture (to main floor of egress and to alternate floor of egress).
- .5 Upon resetting system, auxiliary contacts to return to normal or to operate as pre-programmed.
- .6 Fans: stagger-started upon system reset; timing circuit to separate starting of each fan or set of fans connected to auxiliary contact on system.
  - .1 Timing circuit: controlled by CCU.
- .7 Auxiliary circuits: rated at minimum 2 A, 24 V dc or 120 V ac, fuse-protected.

## **2.10 AMPLIFIERS**

- .1 Modular in construction, solid state in design, for constant voltage distribution to speaker circuits.
- .2 Continuously supervised for proper operation. Loss of power, open or short circuit on input or output of amplifier, or total amplifier failure, to activate trouble sequence at central control unit with visual indication.
- .3 Housed in central control unit/DGP's/transponders. powered through system power supply and supported by standby batteries in case of power failure.
- .4 Riser amplifiers: housed in central control unit, with outputs connected to voice communication risers.
- .5 Standby amplifiers: at central control unit; sized to meet requirements of largest amplifier in that location, with automatic transfer to be on priority basis.
- .6 Amplifiers: 25% spare capacity for future expansion.

## **2.11 WIRING**

- .1 FAS cable, copper conductors, rated 300V.
- .2 To initiating circuits: 18 AWG minimum, and in accordance with manufacturer's requirements.
- .3 To signal circuits: 16 AWG minimum, and in accordance with manufacturer's requirements.
- .4 To speaker circuits: twisted, shielded pairs, and in accordance with manufacturer's requirements.
- .5 To telephone circuits: twisted, shielded pairs, and in accordance with manufacturer's requirements.
- .6 To control circuits: 14 AWG minimum, and in accordance with manufacturer's requirements.
- .7 Risers: twisted, shielded pairs, 1 hour fire-rated configured to eliminate interference and crosstalk.

March 2026

## **2.12 MANUAL ALARM STATIONS**

- .1 Addressable manual pull station:
  - .1 Pull lever, break glass rod, semi-flush wall mounted type, single action, single or 2 stage, electronics to communicate station's status to addressable module/transponder over 2 wires and to supply power to station. Station address to be set on station in field.
  - .2 Pull stations associated with magnetic lock release shall have integral auxiliary contacts to de-energize & release magnetic lock immediately upon activation.

## **2.13 AUTOMATIC ALARM INITIATING DEVICES**

- .1 Addressable thermal fire detectors, combination fixed temperature and rate of rise, non-restorable fixed temperature element, self-restoring rate of rise, fixed temperature 57 and 88 degrees C, rate of rise 8.3 degrees C per minute.
  - .1 Electronics to communicate detector's status to addressable module/transponder.
  - .2 Detector address to be set on detector head in field.
- .2 Addressable variable-sensitivity smoke detectors.
  - .1 Ionization type and air tube sampling type with sampling tubes and protective housing.
  - .2 Electronics to communicate detector's status to addressable module/transponder.
  - .3 Detector address to be set on detector head in field.
  - .4 Sensitivity settings: 7 settings, determined and operated by control panel. No shifting in detector sensitivity due to atmospheric conditions (dust, dirt) within certain parameters.
  - .5 Ability to annunciate minimum of 2 levels of detector contamination automatically with trouble condition at control panel.

## **2.14 AUDIBLE SIGNAL DEVICES**

- .1 Horns: adjustable output with 79 dB low setting and 87 dB high setting, 24 V dc.

## **2.15 VISUAL ALARM SIGNAL DEVICES**

- .1 Strobe type: flashing, white, 24 V dc.
- .2 Designed for surface mounting on ceiling or wall as indicated.
- .3 Adjustable candela setting: 15 cd to 110 cd.

## **2.16 END-OF-LINE DEVICES**

- .1 End-of-line devices to control supervisory current in 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.

## **2.17 REMOTE ANNUNCIATORS**

- .1 LED type, with designation cards to indicate zones.
- .2 Display:
  - .1 Alarms and troubles for alarm initiating circuits.
  - .2 Supervisory alarms and troubles for supervisory initiating circuits.
  - .3 Common system trouble.

March 2026

- .3 Trouble buzzer:
  - .1 Acknowledging trouble at main panel to silence trouble buzzers in system.
- .4 Supervised, with LED test button and alarm and trouble acknowledge button.
- .5 Minimum wiring configuration with main panel and other remote annunciators.

#### **2.18 GRAPHIC DISPLAY**

- .1 Provide graphic display in glazed frame at control panel, showing all floors, stairs, elevators c/w all devices and addresses. Submit as a shop drawing for review by Engineer.

#### **2.19 REMOTE PRINTER**

- .1 Provisions for connection of future printer.

#### **2.20 REMOTE TERMINAL**

- .1 Provisions for connection of future remote terminal.

#### **2.21 AS-BUILT RISER DIAGRAM**

- .1 Fire alarm system riser diagram: in glazed frame minimum size 600 x 600 mm. Submit for review by Engineer.

#### **2.22 ANCILLARY DEVICES**

- .1 Remote relay unit as indicated on drawings and/or riser diagram.

### **PART 3 EXECUTION**

#### **3.1 INSTALLATION**

- .1 Install systems to CAN/ULC-S524.
- .2 Install central control unit and connect to ac power supply, dc standby power.
- .3 Install manual alarm stations and connect to alarm circuit wiring.
- .4 Locate and install detectors and connect to alarm circuit wiring. Mount detectors more than 1 m from air outlets. Maintain at least 600 mm radius clear space on ceiling, below and around detectors. Locate duct type detectors in straight portions of ducts.
- .5 Connect alarm circuits to main control panel.
- .6 Install signal devices to CAN/ULC-S525 and visual signal devices to CAN/ULC-S526 and connect to signalling circuits.
- .7 Connect signalling circuits to main control panel.
- .8 Install end-of-line devices at end of alarm and signalling circuits.
- .9 Install remote annunciator panels and connect to annunciator circuit wiring.
- .10 Install remote relay units to control ancillary devices.
- .11 Sprinkler system: wire alarm and supervisory switches and connect to control panel.
- .12 Connect fire suppression systems to control panel.
- .13 Splices are not permitted.
- .14 Provide necessary raceways, cable and wiring to make interconnections to terminal boxes, annunciator equipment and CCU, as required by equipment manufacturer.

March 2026

- .15 Ensure that wiring is free of opens, shorts or grounds, before system testing and handing over.
- .16 Identify circuits and other related wiring at central control unit, annunciators, and terminal boxes.
- .17 Install speakers and connect to speaker circuits.
- .18 Provide interconnecting circuits between fire alarm control panel and central monitoring equipment. Include two dedicated connections in accordance with CSA remote monitoring requirements.

### 3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical and to CAN/ULC-S537.
- .2 Fire alarm system:
  - .1 Test device and alarm circuit to ensure all initiating devices transmit alarm to control panel and actuate 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 system.
  - .4 Addressable circuits system style DCLA:
    - .1 Test each conductor on DCLA addressable links for capability of providing 3 or more subsequent alarm signals on each side of single open-circuit fault condition imposed near midmost point of each link. Operate Acknowledge/Silence switch after reception of each of 3 signals. Correct imposed fault after completion of each series of tests.
    - .2 Test each conductor on DCLA addressable links for capability of providing 3 or more subsequent alarm signals during ground-fault condition imposed near midmost point of each link. Operate Acknowledge/Silence switch after reception of each of the signals. Correct imposed fault after completion of each series of tests.
  - .5 Addressable circuits system style DCLB:
    - .1 Test each conductor on DCLB addressable links for capability of providing 3 or more subsequent alarm signals online side of single open-circuit fault condition imposed near electrically most remote device on each link. Operate Acknowledge/Silence switch after reception of each of 3 signals. Correct imposed fault after completion of each series of tests.
    - .2 Test each conductor on DCLB addressable links for capability of providing 3 or more subsequent alarm signals during ground-fault condition imposed near electrically most remote device on each link. Operate Acknowledge/Silence switch after reception of each of 3 signals. Correct imposed fault after completion of each series of tests.
- .3 Provide final PROM program re-burn for system Engineer incorporating program changes made during construction.

### 3.3 DEMONSTRATION

- .1 Develop and deliver on-site lectures and demonstration by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system.



March 2026

### **3.4 MAINTENANCE**

- .1 Provide one year's free maintenance with two inspections by manufacturer during warranty period.

### **3.5 MONITORING COMPANY**

- .1 Arrange and pay for remote monitoring by a ULC listed firm, approved by the Owner, for transmission of signals over leased line. Include one year of monitoring. Owner to pay for leased line.
- .2 Include two dedicated connections to ULC listed monitoring equipment to meet ULC listing requirements to allow certification by ULC listed monitoring company.

**END OF SECTION**