Halifax
Regional Centre for Education

382005

Brookside Junior High Boiler Replacement

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EASTPOINT

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END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 Canadian Construction Documents Committee (CCDC):

.1 CCDC 2-2008, Stipulated Price Contract.

1.2 PROJECT CLEANLINESS

.1 Maintain Work in tidy condition, free from accumulation of waste products and debris, including that caused by Owner or other Contractors.

.2 Remove waste materials from site at regularly scheduled times or as directed.

.3 Make arrangements with and obtain permits from Authorities Having Jurisdiction for disposal of waste and debris.

.4 Provide containers for collection of waste materials and debris.

.5 Provide and use marked separate bins for recycling.

.6 Dispose of waste materials and debris off site.

.7 Clean interior areas prior to start of finishing work and maintain areas free of dust and other contaminants during finishing operations.

.8 Store volatile waste in covered metal containers and remove from premises at end of each working day.

.9 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.

.10 Use only cleaning materials recommended by manufacturer of surface to be cleaned and as recommended by cleaning material manufacturer.

.11 Schedule cleaning operations so that resulting dust, debris, and other contaminants will not fall on wet, newly painted surfaces, nor contaminate building systems.

1.3 WASTE MANAGEMENT AND DISPOSAL

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

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 This Section includes requirements for management of construction waste and disposal, which forms the Contractor's commitment to reduce and divert waste materials from landfill and includes the following:

.1 Preparation of a Construction Waste Management Plan that provides guidance on a how to manage common construction wastes in a manner that prioritizes reuse and recycling, and diversion from landfill to the greatest extent possible.

.2 Owner has established that this Project shall generate the least amount of waste possible and that processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors be employed by the Contractor.

1.2 DEFINITIONS

.1 Clean Waste: Untreated and unpainted; not contaminated with oils, solvents, sealants, or similar materials.

.2 Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction, re-modeling, repair, and demolition operations.

.3 Hazardous: Exhibiting the characteristics of hazardous substances including properties such as ignitability, corrosiveness, toxicity, or reactivity.

.4 Non-hazardous: Exhibiting none of the characteristics of hazardous substances, including properties such as ignitability, corrosiveness, toxicity, or reactivity.

.5 Non-toxic: Not poisonous to humans either immediately or after a long period of exposure.

.6 Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.

.7 Recycle: To remove a waste material from the Project site to another site for remanufacture into a new product for reuse by others.

.8 Recycling: The process of sorting, cleansing, treating, and reconstituting solid waste and other discarded materials for the purpose of using the altered form; recycling does not include burning, incinerating, or thermally destroying waste.

.9 Return: To give back reusable items or unused products to vendors for credit.

.10 Reuse: To reuse a construction waste material in some manner on the Project site.

.11 Salvage: To remove a waste material from the Project site to another site for resale or reuse by others.

.12 Sediment: Soil and other debris that has been eroded and transported by storm or well production run off water.

.13 Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.

.14 Toxic: Poisonous to humans either immediately or after a long period of exposure.

.15 Trash: Any product or material unable to be reused, returned, recycled, or salvaged.

.16 Volatile Organic Compounds (VOCs): Chemical compounds common in and emitted by many building products over time through outgassing:

.1 Solvents in paints and other coatings;

.2 Wood preservatives, strippers, and household cleaners; and

.3 Adhesives in particleboard, fiberboard, some plywood, and foam insulation.

.17 Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

.18 Construction Waste Management Plan: A project related plan for the collection, transportation, and disposal of the waste generated at the construction site; the purpose of the plan is to ultimately reduce the amount of material being landfilled.

1.3 REFERENCE STANDARDS

.1 ASTM International (ASTM):

.1 ASTM E1609 01, Standard Guide for Development and Implementation of a Pollution Prevention Program.

.2 Recycling Certification Institute (RCI):

.1 RCI Certification Construction and Demolition Materials Recycling.

1.4 ADMINISTRATIVE REQUIREMENTS

.1 Coordination: Coordinate waste management requirements with all Divisions of the Work for the Project, and ensure that requirements of the Construction Waste Management Plan are followed.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Action Submittals: Provide the following submittals before starting any work of this Section:

.1 Draft Construction Waste Management Plan (Draft CWM Plan): Submit a preliminary listing of anticipated construction or demolition waste streams that have potential to generate the most volume of material indicating methods that will be used to divert construction waste from landfill and source reduction strategies.

.2 Construction Waste Management Plan (CWM Plan): Submit a CWM Plan for this Project before any waste removal from site and that includes the following information:

.1 Material Streams: Analysis of the proposed jobsite waste being generated, including material types and quantities forming a part of identified material streams in the Draft CWM Plan; materials removed from site destined for alternative daily cover at landfill sites and land clearing debris cannot be considered as contributing to waste diversion and will be included as a component of the total waste generated for the site.

.2 Recycling Haulers and Markets: Investigate local haulers and markets for recyclable materials, and incorporate into CWM Plan.

.3 Alternative Waste Disposal: Prepare a listing of each material proposed to be salvaged, reused, recycled, or composted during the course of the Project and the proposed local market for each material.

.4 Landfill Materials: Identify materials that cannot be recycled, reused, or composted and provide explanation or justification; energy will be considered as a viable alternative diversion strategy.

.5 Materials Handling Procedures: A description of the means by which any recycled waste materials will be protected from contamination and a description of the means to be employed in recycling the above materials consistent with requirements for acceptance by designated facilities.

1.6 PROJECT CLOSEOUT SUBMITTALS

.1 Record Documentation: Submit as constructed information in accordance with Section 01 78 00 - Closeout Submittals as follows:

.1 Construction Waste Management Report (CWM Report): Submit a CWM Report for this Project that includes the following information:

.1 Accounting: Submit information indicating total waste produced by the Project. By providing a summary of the disposal certificates/disposal facility receipts.

.2 Composition: Submit information indicating types of waste material and quantity of each material.

.3 Diversion Rate: Submit information indicating total waste diverted from landfill as a percentage of the total waste produced by the Project.

1.7 QUALITY ASSURANCE

.1 Resources for Development of Construction Waste Management Report (CWM Report): The following sources may be useful in developing the Draft Construction Waste Management Plan:

.1 Recycling Haulers and Markets: Investigate local haulers and markets for recyclable materials and incorporate into CWM Plan.

.2 Waste-to-Energy Systems: Investigate local waste-to-energy incentives where systems for diverting materials from landfill for reuse or recycling are not available.

.2 Certifications: Provide proof of the following during the course of the Work:

.1 Compliance Certification: Provide proof that recycling center is third party verified and is listed as a Certified Facility through the registration and certification requirements of the Recycling Certification Institute.

1.8 DELIVERY, STORAGE, AND HANDLING

.1 Storage Requirements: Implement a recycling/reuse program that includes separate collection of waste materials as appropriate to the Project waste and the available recycling and reuse programs in the Project area.

.2 Handling Requirements: Clean materials that are contaminated before placing in collection containers and ensure that waste destined for landfill does not get mixed in with recycled materials:

.1 Deliver materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to recycling process.

.2 Arrange for collection by or delivery to the appropriate recycling or reuse facility.

.3 Hazardous Waste and Hazardous Materials: Handle in accordance with applicable regulations.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 (CWM PLAN) IMPLEMENTATION

.1 Manager: Contractor is responsible for designating an on site party or parties responsible for instructing workers and overseeing and documenting results of the CWM Plan for the Project.

.2 Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, composting, and return methods being used for the Project to Subcontractors at appropriate stages of the Project.

.3 Separation Facilities: Lay out and label a specific area to facilitate separation of materials for potential recycling, salvage, reuse, composting, and return:

.1 Recycling and waste bin areas are to be kept neat and clean and clearly marked in order to avoid contamination of materials.

.2 Hazardous wastes shall be separated, stored, and disposed of in accordance with local regulations.

3.2 SUBCONTRACTOR'S RESPONSIBILITY

.1 Subcontractors shall cooperate fully with the Contractor to implement the CWM Plan.

.2 Failure to cooperate may result in the Owner not achieving their environmental goals and may result in penalties being assessed by the Contractor to the responsible Subcontractors.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 Canadian Environmental Protection Act (CEPA):

.1 SOR/2008-197, Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations.

1.2 ADMINISTRATIVE REQUIREMENTS

.1 Pre-warranty Meeting:

.1 HRCE Representative to establish communication procedures for:

.1 Notifying construction warranty defects.

.2 Determine priorities for type of defects.

.3 Determine reasonable response time.

.2 Contact information for bonded and licensed company for warranty work action: provide name, telephone number, and address of company authorized for construction warranty work action.

.3 Ensure contact is located within local service area of warranted construction, is continuously available, and is responsive to inquiries for warranty work action.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Two weeks before Substantial Performance of the Work, submit to the HRCE Representative, four final copies of operating and maintenance manuals in English.

.3 Provide spare parts, maintenance materials, and special tools of same quality and manufacture as products provided in Work.

.4 Provide evidence, if requested, for type, source, and quality of products supplied.

1.4 FORMAT

.1 Organize data as instructional manual.

.2 Binders: Vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.

.3 When multiple binders are used correlate data into related consistent groupings:

.1 Identify contents of each binder on spine.

.4 Cover: Identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.

.5 Arrange content by systems, under Section numbers, and sequence of Table of Contents.

.6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.

.7 Text: manufacturer's printed data or typewritten data.

.8 Drawings: Provide with reinforced punched binder tab:

.1 Bind in with text; fold larger drawings to size of text pages.

1.5 CONTENTS - PROJECT RECORD DOCUMENTS

.1 Table of Contents for Each Volume:

.1 Provide title of project;

.2 Date of submission;

.3 Names, addresses, and telephone numbers of Consultant and Contractor with name of responsible parties; and

.4 Schedule of products and systems, indexed to content of volume.

.2 For each product or system:

.1 List names, addresses, and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.

.3 Product Data: mark each sheet to identify specific products, component parts, and data applicable to installation; delete inapplicable information.

.4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.

.5 Typewritten Text: As required to supplement product data:

.1 Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01 45 00 - Quality Control.

.6 Training: Provide training records and sign in sheets for all demonstration sessions offered.

1.6 AS-BUILT DOCUMENTS AND SAMPLES

.1 Maintain at site one record copy of:

.1 Contract Drawings.

.2 Specifications.

.3 Addenda.

.4 Change Orders and other modifications to Contract.

.5 Reviewed shop drawings, product data, and samples.

.6 Site test records.

.7 Inspection certificates.

.8 Manufacturer's certificates.

.2 Store record documents and samples in site office apart from documents used for construction:

.1 Provide files, racks, and secure storage.

.3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual:

.1 Label each document "PROJECT RECORD" in neat, large, and printed letters.

.4 Maintain record documents in clean, dry, and legible condition:

.1 Do not use record documents for construction purposes.

.5 Keep record documents and samples available for inspection by Consultant.

1.7 RECORDING INFORMATION ON PROJECT RECORD DOCUMENTS

.1 Record information on set of black line opaque drawings, and in a copy of the Project Manual.

.2 Use felt tip marking pens, maintaining separate colours for each major system, for recording information.

.3 Record information concurrently with construction progress:

.1 Do not conceal Work until required information is recorded.

.4 Contract Drawings and shop drawings: mark each item to record actual construction, including:

.1 Measured depths of elements of foundation in relation to finish first floor datum.

.2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.

.3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.

.4 Site changes of dimension and detail.

.5 Changes made by change orders.

.6 Details not on original Contract Drawings.

.7 Referenced Standards to related shop drawings and modifications.

.5 Specifications: mark each item to record actual construction, including:

.1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.

.2 Changes made by Addenda and change orders.

.6 Other Documents: Maintain manufacturer's certifications, inspection certifications, and site test records, required by individual specifications Sections.

.7 Provide digital photos, if requested, for site records.

1.8 EQUIPMENT AND SYSTEMS

.1 For each item of equipment and each system include description of unit or system, and component parts:

.1 Give function, normal operation characteristics, and limiting conditions.

.2 Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.

.2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.

.3 Include installed colour coded wiring diagrams.

.4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences:

.1 Include regulation, control, stopping, shut-down, and emergency instructions.

.2 Include summer, winter, and any special operating instructions.

.5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

.6 Provide servicing and lubrication schedule, and list of lubricants required.

.7 Include manufacturer's printed operation and maintenance instructions.

.8 Include sequence of operation by controls manufacturer.

.9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

.10 Provide installed control diagrams by controls manufacturer.

.11 Provide Contractor's coordination drawings, with installed colour coded piping diagrams.

.12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

.13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

.14 Include test and balancing reports as specified in Section 01 45 00 - Quality Control and Section 01 91 13 - General Commissioning Requirements.

.15 Underground storage tank inspection documentation, registration, forms, decommissioning, and removal in accordance with CEPA SOR/2008-197.

.16 Additional requirements: As specified in individual specification Sections.

1.9 MATERIALS AND FINISHES

.1 Building products, applied materials, and finishes: Include product data, with catalogue number, size, composition, and colour and texture designations:

.1 Provide information for re-ordering custom manufactured products.

.2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.3 Moisture-protection and weather-exposed products: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.4 Additional requirements: As specified in individual specifications Sections.

1.10 MAINTENANCE MATERIALS

.1 Spare Parts:

.1 Provide spare parts, in quantities specified in individual specification Sections.

.2 Provide items of same manufacture and quality as items in Work.

.3 Deliver to site; place and store.

.4 Receive and catalogue items:

.1 Submit inventory listing to HRCE Representative.

.5 Obtain receipt for delivered products and submit before final payment.

.2 Extra Stock Materials:

.1 Provide maintenance and extra materials, in quantities specified in individual specification Sections.

.2 Provide items of same manufacture and quality as items in Work.

.3 Deliver to site; place and store.

.4 Receive and catalogue items:

.1 Submit inventory listing to HRCE Representative.

.5 Obtain receipt for delivered products and submit before to final payment.

.3 Special Tools:

.1 Provide special tools, in quantities specified in individual specification Section.

.2 Provide items with tags identifying their associated function and equipment.

.3 Deliver to site; place and store.

1.11 DELIVERY, STORAGE, AND HANDLING

.1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.

.2 Store in original and undamaged condition with manufacturer's seal and labels intact.

.3 Store components subject to damage from weather in weatherproof enclosures.

.4 Store paints and freezable materials in a heated and ventilated room.

.5 Remove and replace damaged products at own expense and for review by HRCE Representative.

1.12 WARRANTIES AND BONDS

.1 Develop warranty management plan to contain information relevant to Warranties.

.2 Submit warranty information made available during construction phase, to HRCE Representative for approval before each monthly pay estimate.

.3 Assemble approved information in binder, submit upon acceptance of work and organize binder as follows:

.1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.

.2 List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

.3 Obtain warranties and bonds, executed in duplicate by Subcontractors, suppliers, and manufacturers, within ten days after completion of applicable item of work.

.4 Verify that documents are in proper form, contain full information, and are notarized.

.5 Co-execute submittals when required.

.6 Retain warranties and bonds until time specified for submittal.

.4 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial Performance is determined.

.5 Conduct joint 4 month and 9 month warranty inspection, measured from time of acceptance, by HRCE Representative.

.6 Include information contained in warranty management plan as follows:

.1 Roles and responsibilities of personnel associated with warranty process, including points of contact and telephone numbers within the organizations of Contractors, Subcontractors, manufacturers, or suppliers involved.

.2 Listing and status of delivery of Certificates of Warranty for extended warranty items, to include roofs, HVAC balancing, pumps, motors, and commissioned systems.

.3 Provide list for each warranted equipment, item, feature of construction or system indicating:

.1 Name of item.

.2 Model and serial numbers.

.3 Location where installed.

.4 Name and phone numbers of manufacturers or suppliers.

.5 Names, addresses, and telephone numbers of sources of spare parts.

.6 Warranties and terms of warranty: include one-year overall warranty of construction. Indicate items that have extended warranties and show separate warranty expiration dates.

.7 Cross-reference to warranty certificates as applicable.

.8 Starting point and duration of warranty period.

.9 Summary of maintenance procedures required to continue warranty in force.

.10 Cross-Reference to specific pertinent Operation and Maintenance manuals.

.11 Organization, names, and phone numbers of persons to call for warranty service.

.12 Typical response time and repair time expected for various warranted equipment.

.4 Contractor's plans for attendance at 4 and 9 month post-construction warranty inspections.

.5 Procedure and status of tagging of equipment covered by extended warranties.

.6 Post copies of instructions near selected pieces of equipment where operation is critical for warranty and/or safety reasons.

.7 Respond in timely manner to oral or written notification of required construction warranty repair work.

.8 Written verification to follow oral instructions:

.1 Failure to respond will be cause for the HRCE Representative to proceed with action against Contractor.

1.13 WARRANTY TAGS

.1 Tag, at time of installation, each warranted item. Provide durable, oil- and water-resistant tag approved by HRCE Representative.

.2 Attach tags with copper wire and spray with waterproof silicone coating.

.3 Leave date of acceptance until project is accepted for occupancy.

.4 Indicate the following information on tag:

.1 Type of product/material.

.2 Model number.

.3 Serial number.

.4 Contract number.

.5 Warranty period.

.6 Inspector's signature.

.7 Construction Contractor.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 General requirements relating to commissioning of projects components and systems, specifying general requirements to FPT of components, equipment, sub-systems, systems, and integrated systems.

.2 Related Requirements:

.1 Section 01 91 31 - Commissioning Plan.

.2 Section 01 91 33 - Commissioning Forms.

.3 Section 01 91 41 - Commissioning Training Requirements.

.3 Reference Standards:

.1 ASHRAE Guideline 1.1-2007 HVAC&R Technical Requirements for the Commissioning Process.

.2 ASHRAE Guideline 0-2005 The Commissioning Process.

.3 CAN/CSA 22.1-15 Canadian Electrical Code.

.4 NBCC-15 National Building Code of Canada.

.4 Acronyms:

.1 AFD - Alternate Forms of Delivery, service provider.

.2 Cx - Commissioning.

.3 EMCS - Energy Monitoring and Control Systems.

.4 O&M - Operation and Maintenance.

.5 PFT Checklists - Pre-Functional Testing Checklists.

.6 FPT - Functional Performance Testing.

.7 TAB - Testing, Adjusting, and Balancing.

1.2 GENERAL

.1 Cx is a planned program of tests, procedures, and checks carried out systematically on systems and integrated systems of the finished Project. Cx is performed after systems and integrated systems are completely installed, functional, and Contractor’s Performance Verification responsibilities have been completed and approved. Objectives:

.1 Verify installed equipment, systems, and integrated systems operate in accordance with Contract Documents and design criteria and intent.

.2 Effectively train O&M staff.

.2 Contractor assists in Cx process, operating equipment and systems, troubleshooting and making adjustments as required:

.1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be interactively with each other as intended in accordance with Contract Documents and design criteria.

.2 During these checks, adjustments to be made to enhance performance and meet environmental or user requirements.

.3 Design Criteria: as per client's requirements or determined by designer and to meet Project functional and operational requirements.

.4 AFD managed projects the term HRCE Representative in Cx specifications to be interpreted as AFD Service Provider.

1.3 COMMISSIONING OVERVIEW

.1 For Cx responsibilities refer to Section 01 91 31 - Commissioning Plan.

.2 Cx to be a line item of Contractors cost breakdown.

.3 Cx activities supplement field quality and testing procedures described in relevant technical sections.

.4 HRCE Representative will issue Interim Acceptance Certificate when:

.1 Completed Cx documentation has been received, reviewed for suitability, and approved by HRCE Representative.

.2 Equipment, components, and systems have been commissioned.

.3 O&M training has been completed.

.5 In general, systems to be commissioned (Cx) include but are not limited to (Refer to Commissioning Plan for further scope details):

.1 Mechanical:

.1 Plumbing.

.2 HVAC.

.3 Controls.

.4 Inter-connection/integration of systems.

.2 Electrical:

.1 Power Distribution.

1.4 NON-CONFORMANCE TO PERFORMANCE VERIFICATION REQUIREMENTS

.1 Should equipment, system components, and associated controls be incorrectly installed or malfunction during Cx, correct deficiencies, re-verify equipment, and components within the unfunctional system, including related systems as deemed required by HRCE Representative, to ensure effective performance.

.2 Costs for corrective work, additional tests, inspections, to determine acceptability and proper performance of such items to be borne by Contractor. Above costs to be in form of progress payment reductions or hold-back assessments.

1.5 PRE-CX REVIEW

.1 Before Construction:

.1 Review Contract Documents, confirm by writing to HRCE Representative:

.1 Adequacy of provisions for Cx.

.2 Aspects of design and installation pertinent to success of Cx

.2 During Construction:

.1 Co-ordinate provision, location, and installation of provisions for Cx.

.3 Before start of Functional Performance Testing:

.1 Have completed Cx Plan up-to-date.

.2 Ensure installation of related components, equipment, sub-systems, and systems is complete.

.3 Fully understand Cx requirements and procedures.

.4 Have Cx documentation shelf-ready.

.5 Understand completely design criteria and intent and special features.

.6 Submit complete start-up documentation to HRCE Representative.

.7 Have Cx schedules up-to-date.

.8 Ensure As-Built system schematics are available.

.9 Inform HRCE Representative in writing when pre-functional installation verification is complete and are ready to begin Functional Performance Testing.

.4 Inform HRCE Representative in writing of discrepancies and deficiencies on finished works.

1.6 CONFLICTS

.1 Report conflicts between requirements of this section and other sections to HRCE Representative before start-up and obtain clarification.

.2 Failure to report conflict and obtain clarification will result in application of most stringent requirement.

1.7 ACTION AND INFORMATIONAL SUBMITTALS

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

.1 Submit no later than 4 weeks after award of Contract:

.1 Preliminary Cx task within the construction schedule.

.2 Request in writing to HRCE Representative for changes to submittals and obtain written approval at least 4 weeks prior to start of Cx.

.3 Submit proposed Cx procedures to HRCE Representative where not specified and obtain written approval at least 4 weeks prior to start of Cx.

.4 Provide additional documentation relating to Cx process required HRCE Representative.

1.8 COMMISSIONING DOCUMENTATION

.1 Refer to Section 01 91 31 - Commissioning Plan and Section 01 91 33 - Commissioning Forms: PFT checklists and template FPT Forms for requirements and instructions for use.

.2 The HRCE Representative may request further documentation necessary for the commissioning process.

.3 Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting, and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information,

including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the HRCE Representative.

.4 HRCE Representative to review and approve Cx documentation.

.5 Provide completed and reviewed Cx documentation to HRCE Representative.

.6 Contractor's responsibility for deviations in submittals from requirements of the Contract Documents is not relieved by the HRCE Representative's review.

1.9 COMMISSIONING SCHEDULE

.1 Provide detailed Cx schedule as part of construction:

.1 Detailed Cx schedule to be broken down by commissioned systems and their associated equipment.

.2 Detailed Cx schedule to included phasing, if applicable.

.3 Refer to Section 01 91 31 - Commissioning Plan for an example of the level of detail required for commissioning schedule.

.2 Provide adequate time for Cx activities prescribed in technical sections and commissioning sections including:

.1 Approval of Cx reports.

.2 Verification of reported results.

.3 Repairs, retesting, re-commissioning, and re-verification.

.4 Training.

1.10 COMMISSIONING MEETINGS

.1 Convene Cx meetings following project meetings.

.2 Purpose: to resolve issues, monitor progress, and identify deficiencies relating to Cx.

.3 Continue Cx meetings on regular basis until commissioning deliverables have been addressed.

.4 At 75% construction completion stage. HRCE Representative to call a separate Cx scope meeting to review progress, discuss schedule of equipment start-up activities, and prepare for Cx. Issues at meeting to include:

.1 Review duties and responsibilities of Contractor and Subcontractors, addressing delays and potential problems.

.2 Determine the degree of involvement of trades and manufacturers representatives in the commissioning process.

.5 Thereafter Cx meetings to be held until project completion and as required during equipment start-up and functional testing period.

.6 Meeting will be chaired by HRCE Representative, who will record and distribute minutes.

.7 Ensure Subcontractors and relevant manufacturer representatives are present at 60% and subsequent Cx meetings and as required.

1.11 STARTING AND TESTING

.1 Contractor assumes liabilities and costs for inspections. Including disassembly and re-assembly after approval, starting, testing, and adjusting, including supply of testing equipment.

1.12 WITNESSING OF STARTING AND TESTING

.1 Provide 28 days notice prior to commencement.

.2 HRCE Representative may witness major equipment start-up and testing.

.3 HRCE Representative may be present at tests performed and documented by sub-trades, suppliers, and equipment manufacturers.

1.13 MANUFACTURER'S INVOLVEMENT

.1 Factory testing: manufacturer to:

.1 Coordinate time and location of testing.

.2 Provide testing documentation for approval by HRCE Representative.

.3 Arrange for HRCE Representative to witness tests.

.4 Obtain written approval of test results and documentation from HRCE Representative before delivery to site.

.2 Obtain manufacturers installation, start-up, and operations instructions prior to start-up of components, equipment, and systems and review with HRCE Representative:

.1 Compare completed installation with manufacturers published data, record discrepancies, and review with manufacturer.

.2 Modify procedures detrimental to equipment performance and review same with manufacturer before start-up.

.3 Integrity of warranties:

.1 Use manufacturers trained start-up personnel where specified elsewhere in other divisions or required to maintain integrity of warranty.

.2 Verify with manufacturer that testing as specified will not void warranties.

.4 Qualifications of manufacturers personnel:

.1 Experienced in design, installation, and operation of equipment and systems.

.2 Ability to interpret test results accurately.

.3 To report results in clear, concise, and logical manner.

1.14 PROCEDURES

.1 Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing, and Cx.

.2 Conduct start-up and testing in following distinct phases:

.1 Included in delivery and installation:

.1 Verification of conformity to specification, approved shop drawings, and completion of PFT forms.

.2 Visual inspection of quality of installation.

.2 Start-up: follow manufacturer accepted start-up procedures.

.3 Operational testing: document equipment performance.

.4 System FPT: include repetition of tests after correcting deficiencies.

.5 Post-substantial performance verification: to include fine-tuning.

.3 Correct deficiencies and obtain approval from HRCE Representative after distinct phases have been completed and before commencing next phase.

.4 Document require tests on approved FPT forms.

.5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by HRCE Representative. If results reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:

.1 Minor equipment/systems: implement corrective measures approved by HRCE Representative.

.2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by HRCE Representative.

.3 If evaluation report concludes that major damage has occurred, HRCE Representative shall reject equipment:

.1 Rejected equipment to be remove from site and replace with new.

.2 Subject new equipment/systems to specified start-up procedures.

1.15 START-UP DOCUMENTATION

.1 Assemble start-up documentation and submit to HRCE Representative for approval before commencement of commissioning.

.2 Start-up documentation to include, where applicable, but not limited to:

.1 Factory and on-site test certificates for specified equipment.

.2 Pre-start-up inspection reports.

.3 Signed installation/start-up check lists.

.4 Contractor and Manufacturer Start-up reports.

.5 TAB Report.

.6 PFT Checklists.

.7 Control verification reports.

.8 Step-by-step description of complete start-up procedures, to permit HRCE Representative to repeat start-up at any time.

1.16 OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS

.1 After start-up, operate, and maintain equipment and systems as directed by equipment/system manufacturer.

.2 With assistance of manufacturer develop written maintenance program and submit HRCE Representative for approval before implementation.

.3 Operate and maintain systems for length of time required for commissioning to be completed.

.4 After completion of commissioning, operate, and maintain systems until issuance of certificate of interim acceptance.

1.17 TEST RESULTS

.1 If start-up, testing, and/or FPT produce unacceptable results, repair, replace, or repeat specified starting and/or FPT procedures until acceptable results are achieved.

.2 Provide manpower and materials, assume costs for re-commissioning.

1.18 START OF COMMISSIONING

.1 Notify HRCE Representative at least 10 days prior to start of Cx.

.2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.

1.19 INSTRUMENTS/EQUIPMENT

.1 Submit to HRCE Representative for review and approval:

.1 Complete list of instruments proposed to be used.

.2 Listed data including serial number, current calibration certificate, calibration date, calibration expiry date, and calibration accuracy.

.3 As per TAB requirements, calibration certificates to be completed within the past 3 month.

.2 Provide the following equipment as required:

.1 2-way radios.

.2 Calibrated temperature and humidity meter.

.3 Ladders.

.4 Equipment as required to complete work.

1.20 COMMISSIONING FUNCTIONAL PERFORMANCE TESTING (FPT)

.1 Carry out Cx:

.1 Under actual operating conditions, over entire operating range, in all modes.

.2 On independent systems and interacting systems.

.2 Cx procedures to be repeatable and reported results are to be verifiable.

.3 Follow equipment manufacturers operating instructions.

.4 EMCS trending to be available as supporting documentation for performance verification.

.5 HRCE Representative to direct and document activities and results.

.6 Address assigned issues from functional performance testing. Notify HRCE Representative once they have been addressed along with photos, so they can be verified.

1.21 WITNESSING COMMISSIONING

.1 HRCE Representative may witness activities and verify results.

1.22 AUTHORITIES HAVING JURISDICTION

.1 Where specified start-up, testing, or commissioning procedures duplicate verification requirements of Authority Having Jurisdiction, arrange for authority to witness

procedures so as to avoid duplication of tests and to facilitate expedient acceptance of facility.

.2 Obtain certificates of approval, acceptance, and compliance with rules and regulation of Authority Having Jurisdiction.

.3 Provide copies to HRCE Representative within 5 days of test and with Cx report.

1.23 COMMISSIONING CONSTRAINTS

.1 Since access into secure or sensitive areas will be very difficult after occupancy it is necessary to complete Cx of occupancy, weather, and seasonal sensitive equipment and systems in these areas before issuance of the Interim Certificate, using, if necessary, simulated thermal loads.

1.24 EXTRAPOLATION OF RESULTS

.1 Where Cx of weather, occupancy, or seasonal-sensitive equipment or systems cannot be conducted under near-rated or near-design conditions, extrapolate part-load results to design conditions when approved by HRCE Representative in accordance with equipment manufacturers instructions, using manufacturers data, with manufacturers assistance, and using approved formulae.

1.25 EXTENT OF VERIFICATION

.1 Elsewhere:

.1 Provide manpower and instrumentation to verify up to 100% of reported results, unless specified otherwise in other sections.

.2 Number and location to be at discretion of HRCE Representative.

.3 Conduct tests repeated during verification under same conditions as original tests, using same test equipment and instrumentation.

.4 Review and repeat commissioning of systems if inconsistencies found in more than 20% of reported results.

.5 Perform additional commissioning until results are acceptable to HRCE Representative.

1.26 REPEAT VERIFICATIONS

.1 Assume costs incurred by HRCE Representative and for third and subsequent verifications where:

.1 Verification of reported results fail to receive HRCE Representative's approval.

.2 Repetition of second verification again fails to receive approval.

.3 HRCE Representative deems Contractor's request for second verification was premature.

1.27 SUNDRY CHECKS AND ADJUSTMENTS

.1 Make adjustments and changes which become apparent as Cx proceeds.

.2 Perform static and operational checks as applicable and as required.

1.28 DEFICIENCIES, FAULTS, AND DEFECTS

.1 Correct deficiencies found during start-up and Cx to satisfaction of HRCE Representative.

.2 Report problems, faults, or defects affecting Cx to HRCE Representative in writing. Stop Cx until problems are rectified. Proceed with written approval from HRCE Representative.

1.29 COMPLETION OF COMMISSIONING

.1 Upon completion of Cx leave systems in normal operating mode.

.2 Except for warranty and seasonal verification activities specified in Cx specifications, complete Cx prior to issuance of Interim Certificate of Completion.

.3 Cx to be considered complete when contract Cx deliverables have been submitted and accepted by HRCE Representative.

1.30 ACTIVITIES UPON COMPLETION OF COMMISSIONING

.1 When changes are made to baseline components or system settings established during Cx process, provide updated Cx form for affected item.

1.31 TRAINING

.1 In accordance with Section 01 91 41 - Commissioning Training Requirements.

1.32 MAINTENANCE MATERIALS, SPARE PARTS, AND SPECIAL TOOLS

.1 Supply, deliver, and document maintenance materials, spare parts, and special tools as specified in contract.

1.33 OCCUPANCY

.1 Cooperate fully with HRCE Representative during stages of acceptance and occupancy of facility.

1.34 INSTALLED INSTRUMENTATION

.1 Use instruments installed under Contract for TAB and FPT if:

.1 Accuracy complies with these specifications.

.2 Calibration certificates have been deposited with HRCE Representative.

.2 Calibrated EMCS sensors may be used to obtain performance data, provided that sensor calibration has been completed and accepted

1.35 PERFORMANCE VERIFICATION TOLERANCES

.1 Application tolerances:

.1 Specified range of acceptable deviations of measured values from specified values or specified design criteria. Except for special areas, to be within +/- 10% of specified values.

.2 Instrument accuracy tolerances:

.1 To be of higher order of magnitude than equipment or system being tested.

.3 Measurement tolerances during verification:

.1 Unless otherwise specified actual values to be within +/- 2% of recorded values.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Enclosed is a Commissioning Plan describing requirements and processes pertaining to the commissioning process of this project. The contractor shall cooperate during the commissioning process and provide materials and equipment as described. The attached Commissioning plan is a DRAFT; however, it represents the current commissioning process of this project.

.2 The Commissioning Plan is a living document and if changes are required, the change will be discussed with the commissioning team before the changes are incorporated. These changes will be summarized and submitted to the commissioning team for final review. The team will have two (2) weeks to provide comments or request adjustments. After this time, CxP will issue an updated version of the plan to the commissioning team for their records incorporating these changes.

.3 The plan will be in draft form until the end of the project. At this point, it will be updated with any changes to the project's commissioning process. It will be submitted to the owner for their records.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

EastPoint Project No. 382005

April 10, 2025

DRAFT COMMISSIONING PLAN – V1
BROOKSIDE JUNIOR HIGH BOILER REPLACEMENT
2239 PROSPECT ROAD, HATCHET LAKE, NS

Image from HRCE website: https://bsj.hrce.ca/

Report Submitted to:

Halifax Regional Centre for Education

Matt Flewwelling
33 Spectacle Lake Dr,
Dartmouth, NS B3B 1X7

By:
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Consulting Engineers and Architects
and Project Managers
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1.0 INTRODUCTION

Commissioning is a quality assurance process to help ensure all building systems perform interactively and according to the design intent and the owner's operational requirements. Commissioning is conducted by a team independent of the design and construction teams. It provides the owner with a means to independently verify the project's planning, design, construction, and operational process. The commissioning process seeks to provide optimized energy efficiency, system maintainability, and indoor air quality.

Relevant Commissioning Guidelines/Standards:

- ASHRAE Guideline 0 – The Commissioning Process

The commissioning process, during both the design and construction phases, has the following steps:

- Establish the commissioning team
- Develop commissioning specifications
- Develop a preliminary commissioning (Cx) plan:
    - Develop: Pre-functional testing forms
    - Develop: Functional Testing Forms
    - Develop: Training Plan
    - Develop: Draft Cx Schedule
- Review contractor submittals against Cx Plan, OPR, and BOD
- Conduct and chair commissioning meetings
- Review the installing contractors pre-functional testing process and documents
- Direct the installing contractors & manufacturers' representatives through functional performance testing process
- Verify training of staff by installing contractors & manufacturers' representatives.
- Review O&M documents

1.1 DEFINITIONS

In order to understand the Commissioning Plan, the following terms have been defined. Any reference to these terms carries the stated and associated working definition outlined herein.

American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) - an American professional association seeking to advance heating, ventilation, air conditioning and refrigeration systems design and construction.

Basis of Design (BOD) - The information necessary to accomplish the owners project requirements, including system description, indoor environment quality criteria, design assumptions, and reference of applicable codes, standards, regulations and guidelines.

Commissioning Plan - Defines the scope and approach to the Total Building commissioning program that is to be executed for the project.

Commissioning Providers - The internal technical resource staff of the CxP that will be responsible for the execution of the on-site testing activities.

Commissioning Team - Personnel that will be directly involved in the building commissioning process. The commissioning team consists of the owner's representatives, CxP, Contractors, Consultants and O&M Staff.

Functional Performance Testing - Systems performance tests are specific hands-on tests, used to verify the Functional Performance Testing at the equipment and associated systems meet the specified design parameters and operate as fully integrated components or systems through their respective level of automation. This testing also confirms the capabilities of each system to meet the requirements of the facility and the Owner's Project Requirements.

Owner's Project Requirements (OPR) – A written document that details the ideas, concepts and criteria determined by the owner to be important to the success of the project.

Pre-Functional Performance Testing - Are specific hands-on tests, used to verify the non-powered Performance Testing at the equipment and associated systems meet the specified design parameters. This testing also confirms the capabilities of each system to meet the requirements of the facility and the Owner's Project Requirements.

2.0 BUILDING INFORMATION

Project Name:	**Brookside Junior High Boiler Replacement**
Location:	**Hatchet Lake, NS**
Building Type:	**High School**
School Size:	**300 Students**

3.0 COMMISSIONING TEAM AND RESPONSIBILITIES

Table 1: Commissioning Team

Title	Company	Contact Name(s)	Contact Information
Operator	***(Company Name)*** ***(Company Address)***	***(First Name / Surname)***	***(Phone Number)*** ***(Email Address)***
Owner's Project Manager	**HRCE**	**Matt Flewwelling** Capital Project Manager	Phone: TBD Email: TBD
Commissioning Providers	**EastPoint**	**Keith Estey** Senior Commissioning Engineer **Michael MacDonald** Senior Commissioning Engineer	Phone: TBD Email: TBD a Phone: TBD Email: TBD
Mechanical Designer	**EastPoint**	**Ryan Cooke** Senior Mechanical / Energy Engineer **Mike Nicholson** Mechanical Engineer	Phone: TBD Email: TBD Phone: TBD Email: TBD
Electrical Designer	**EastPoint**	**Thomas Baltzer** Senior Electrical Engineer **Dyland Mason** Electrical EIT	Phone: TBD Email: TBD Phone: TBD Email: TBDa
General Contractor	TBD	TBD	TBD
Mechanical Contractor	TBD	TBD	TBD
Electrical Contractor	TBD	TBD	TBD
Controls Contractor	TBD	TBD	TBD

Table 2: Commissioning Team Responsibilities

	Design Team Lead	Owner Project Manager	Commissioning Provider	Discipline Designers	General Contractor + Subcontractors	User/Operator
Plan and schedule design meetings	☒	☒	☐	☐	☐	☒
Plan and schedule construction meetings	☐	☐	☐	☐	☒	☐
Plan and schedule site inspections and operation tests	☐	☒	☒	☐	☐	☐
Develop Commissioning plan and edit as necessary	☐	☐	☐	☒	☐	☐

	Design Team Lead	Owner Project Manager	Commissioning Provider	Discipline Designers	General Contractor + Subcontractors	User/Operator
Review and comment on Commissioning plan	☐	☒	☐	☐	☒	☒
Prepare Specifications	☒	☐	☒	☒	☐	☐
Review Contractor Submittals	☒	☐	☒	☒	☐	☐
Develop Cx Schedule	☐	☐	☒	☐	☒	☐
Develop Pre-Functional Testing Forms	☐	☐	☒	☐	☐	☐
Execute Pre-Functional Testing Forms	☐	☐	☐	☐	☒	☐
Evaluate TAB Reports	☒	☐	☒	☒	☐	☐
Organize O&M manual	☐	☐	☐	☐	☒	☐
Review O&M manuals	☒	☐	☒	☒	☐	☒
Determine requirements of operator training	☒	☒	☒	☒	☐	☐
Conduct / Witness operator training	☐	☒	☐	☐	☒	☒
Update Systems Manual	☐	☐	☐	☐	☐	☐

4.0 COMMUNICATION AND REPORTING OF THE COMMISSIONING PROCESS

The Commissioning Team shall follow the process outlined in Table 3, using this as an identification tool for proper management, communication, and reporting throughout the commissioning process. The Commissioning Team shall understand the following to ensure their responsibilities in the event an issue arises.

Table 3: Communication and reporting of the commissioning process

Issue	Process
For requests for information (RFI) or formal documentation requests.	The Commissioning Provider (CxP) goes first to the Owners Project Manager. (Copy to Construction Mgr.).
For verbal information or clarification.	The CxP goes directly to the informed party.
For notifying contractors of deficiencies.	The CxP documents deficiencies through the CxP's Issues log and notifies Owner's Project Manager/Responsible Party.
For scheduling monthly commissioning meetings	The CxP shall specify the times for monthly commissioning meetings. Typically, in concert with General progress meetings. General Contractor is ultimately responsible scheduling trades.
For scheduling systems tests or training.	The CxA can suggest times and durations for functional testing and training but scheduling the appropriate trades is ultimately the responsibility of the General Contractor.
For making requests for significant changes.	The CxP has no authority to issue change orders, this is the responsibility of the Owner's Project Manager.
Subcontractor disagreement with requests or interpretations by the CxP.	The subcontractor shall try to resolve with the CxP through review of project contract documents. If resolution is not achieved, the Owner's Project Manager shall be informed to assist resolution.

5.0 COMMISSIONING SYSTEMS

The following systems will be the list of all systems included in the Commissioning process. The following systems will be commissioned by CxP:

Mechanical Systems

- Boilers and associated equipment
- Energy Recovery Ventilator
- Heat Pump
- New Building Controls

Electrical Systems

- Power Distribution to new equipment.

6.0 DOCUMENTATION UPDATING

The following commissioning documents listed in Table 4 are to be delivered as part of the commissioning process, and should be updated throughout the life of the building by operation and maintenance staff, especially after recommissioning has occurred and with the installation of new systems as the building ages.

Table 4: List of Commissioning Documents

List of Expected Work Products
Training Program
Commissioning Schedules
Pre-Functional and Functional Commissioning Procedures
Project Commissioning Specifications
Final Commissioning Plan
Commissioning Meeting Minutes
Site Observation Reports and Issues Logs
Functional Performance Testing Reports
Final Commissioning Issues Log (issues and resolutions)

7.0 COMMISSIONING OVERVIEW

7.1 START UP MEETING

At roughly 75% completion of construction, a start-up meeting shall be called by the Commissioning Provider to engage the mechanical and electrical disciplines. In attendance shall be the Owners Project Manager, Mechanical and Electrical Designers, general contractor representative, and all other designated subcontractors.

These meetings will review the reporting structure, lines of communication, the different parties' responsibilities, and the general schedule for site inspections, startup of equipment, and training. CxP will use this opportunity to go through the Commissioning Schedule in detail and update it using the input from the project team. An example commissioning schedule that can be utilized by the Construction team is included in **Appendix A**.

The desired outcome of these meetings is that all involved parties have a good understanding of the commissioning process and their individual responsibilities.

Minutes from these meetings will be included in **Appendix B** when the plan is finalized at the end of the project.

7.2 COMMISSIONING PLAN

Following the Start Up commissioning meeting, the Commissioning Provider will update the commissioning plan. The commissioning schedule that was discussed during the Start Up meeting will be added to the plan. It will then be submitted for approval by the Owners Project Manager. The Commissioning Plan is a live document and can be updated throughout the Commissioning procedure. Each time the Commissioning Plan is updated it must be submitted for the Owner's Approval and then distributed among the Commissioning Team members.

7.3 SUBMITTALS

The Commissioning Provider shall provide the General Contractor and all subcontractors responsible for commissioned equipment with a list of the documentation required for the commissioning process. This list will be delivered through the Owners Project Manager.

The data required for Commissioning Provider review is typically similar to the requirements of the Designers. It will include installation and startup procedures, O&M data, performance data and controls drawings. The Commissioning Provider will review the documents to ensure they meet the requirements of the basis of design and commissioning related items mentioned in the contract documents. The Commissioning Provider reviews for energy efficiency, system operability and maintainability and compliance with the Owner's Project Requirements.

The recommendations from these reviews will be formally documented by the Commissioning Provider and will be forwarded to the Owner's Project Manager.

7.4 SITE MEETINGS / REVIEW

The Commissioning Provider will suggest times for the Project Commissioning Meetings as required. These meetings will be scheduled by the Owners Project Manager or General Contractor.

At these meetings, the General Contractor will have the opportunity to report on the construction progress as it relates to commissioning and share any information that will affect the commissioning schedule or equipment / systems to be commissioned. CxP will use this opportunity to update the commissioning status. CxP will chair and minute these meetings.

Any deficiencies will be documented in the CxP issues log, which an example of the log can be found in **Appendix C**.

7.5 PRE-FUNCTIONAL TESTING

Prior to the startup of the equipment, all shall be inspected, and the correct installation be verified by the installing contractor by filling out appropriate pre-functional checklists and provision of required sign-off reports. This is done to reduce delays and damage during initial startup. There is to be no sampling at this step (100% sampling rate). The Commissioning Provider does not need to be present during each test and has the right to inspect a sample of equipment of their choosing.

All deficiencies are to be recorded and corrected before Startup check and ultimately Functional Performance testing can begin.

Sample forms can be found in **Appendix D.**

7.6 START-UP CHECK

The startup check is the checkpoint to ensure each specific piece of equipment is operating independently as designed. The completion of this phase will be denoted by a fully filled set of Pre-Functional Commissioning forms along with all prerequisite contractor documentation provided.

All deficiencies are to be recorded and corrected prior to commencing Functional Performance Testing.

7.7 FUNCTIONAL PERFORMANCE TESTING (FPT)

The Functional Test is not only the testing of each piece of equipment but is also a check that the pieces of equipment together produce the proper final result.

The Commissioning Provider is not responsible for coordinating the functional tests but will give suggestions. It is ultimately the responsibility of the General Contractor to schedule these tests

It is the responsibility of the Commissioning Provider to document all results of the Functional Performance Tests. Any deficiencies are to be corrected by the subcontractor and retesting will be scheduled by the General Contractor, if required. Any disputes regarding the requirement of retesting between the Commissioning Provider and the subcontractor shall be handled by the Owner's Project Manager.

Following the General Contractor and all subcontractors FPT and are satisfied with system operations the Owners Project Manager is to be notified.

An example FPT form can be found in **Appendix E**. Once the controls shop drawings are reviewed by the consultant team, the CxP will develop all of the testing procedures and provide them to the team for review.

7.8 TRAINING

The CxP and the Owners Project Manager will determine all systems for which formalized training is required. This will happen during the design phase. CxP will then develop the Operator Training signoff forms to be approved by the Owners Project Manager with all stakeholders input. The training package will then be provided to the general contractor for execution. An example training plan and sign off forms can be found in **Append F**.

Appendix A – Example Commissioning Schedule

EASTPOINT

Description	Area/Floor	Location	Phase	Installation Complete	Static/Dynamic Reviews Complete	Start-up Complete	Balancing Complete	Controls Verification Complete	Ready for CxA Testing (i.e, No Open Issues)	Pre-Functional Review Complete (Cx Documentation, Installation Verification)	Functional Performance Testing Complete	FPT Issue Reports Submitted	Cx Issues Resolved	Training Complete	Handover Complete (Systems Manual, Seasonal/Deferred Testing, Warranty Review)	Comments
Responsibility				(Contractor)	(Contractor)	(Contractor / OEM)	(Contractor)	(Contractor)	(Contractor)	(EastPoint)	(EastPoint)	(EastPoint)	(Contractor)	(Contractor / OEM)	(EastPoint)	
Ventilation																
Heating																
Plumbing																

DRAFT

EASTPOINT

Description	Area/Floor	Location	Phase	Installation Complete	Static/Dynamic Reviews Complete	Start-up Complete	Balancing Complete	Controls Verification Complete	Ready for CxA Testing (i.e, No Open Issues)	Pre-Functional Review Complete (Cx Documentation, Installation Verification)	Functional Performance Testing Complete	FPT Issue Reports Submitted	Cx Issues Resolved	Training Complete	Handover Complete (Systems Manual, Seasonal/Deferred Testing, Warranty Review)	Comments
Fire Protection																
Electrical																
Responsibility																
Panels																
Distribution																

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Appendix B – Commissioning Meeting Minutes

PROJECT MANAGEMENT SYSTEM

EP Project No: _____
EP Project Title: _____
EP Project Manager: _____

Client Project No: _____
Client Name: _____
Client Contact: _____

Attachments: _____

Meeting Name: _____
Meeting #: _____

Meeting Date: _____
Start Time: _____
End Time: _____
Timezone: _____
Meeting Location: _____

Sample

Scheduled Attendees:

Person	Company	Phone	Email	Present	Absent	Minutes Approval Requested?	Minutes Approved?	Minutes Comments
Michael MacDonald	EastPoint			☐	☐	No	N/A	
Keith Estey	EastPoint			☐	☐	No	N/A	
				☐	☐	No	N/A	
				☐	☐	No	N/A	
				☐	☐	No	N/A	
				☐	☐	No	N/A	
				☐	☐			
				☐	☐			
				☐	☐			
				☐	☐			
				☐	☐			
				☐	☐			

Agenda:

1- INTRODUCTION

	Agenda #	Meeting Origin	Title	Assignment	Due Date	Priority	Status	Old/New?
	1.1	1	General Safety Reminders	Keith Estey	5/1/2023	High	Closed	Old

EASTPOINT ENGINEERING

PROJECT MANAGEMENT SYSTEM

EP Project No: _____
EP Project Title: _____
EP Project Manager: _____

Client Project No: _____
Client Name: _____
Client Contact: _____

Attachments: _____

Meeting Name: _____
Meeting #: _____

Meeting Date: _____
Start Time: _____
End Time: _____
Timezone: _____
Meeting Location: _____

Scheduled Attendees:

Official Documented Meeting Minutes:								
	1.2	2	Housekeeping	Information Only	6/1/203	Low	Open	Old
	1.3	3	Safety Observations	Information Only	7/1/203	Medium	Open	New

2- COMMISSIONING SCHEDULE

	Agenda #	Meeting Origin	Title	Assignment	Due Date	Priority	Status	Old/New?
	2.1		General Safety Reminders	Keith Estey	5/1/2023	High	Closed	Old
	2.2		General Safety Reminders	Keith Estey	5/1/2023	High	Closed	Old

Sample

PROJECT MANAGEMENT SYSTEM

EP Project No: _____
EP Project Title: _____
EP Project Manager: _____

Client Project No: _____
Client Name: _____
Client Contact: _____

Attachments: _____

Meeting Name: _____
Meeting #: _____

Meeting Date: _____
Start Time: _____
End Time: _____
Timezone: _____
Meeting Location: _____

Scheduled Attendees:

	2.3		General Safety Reminders	Keith Estey	5/1/2023	High	Closed	Old
	2.3		General Safety Reminders	Keith Estey	5/1/2023	High	Closed	Old

3- INSTALLATION VERIFICATION (INCL. CX SOFTWARE)

	Agenda #	Meeting Origin	Title	Assignment	Due Date	Priority	Status	Old/New?
	3.1			Information Only				
	3.2		General Safety Reminders	Keith Estey	5/1/2023	High	Closed	Old
	3.3		General Safety Reminders	Keith Estey	5/1/2023	High	Closed	Old

Sample

PROJECT MANAGEMENT SYSTEM

EP Project No: _____
EP Project Title: _____
EP Project Manager: _____

Client Project No: _____
Client Name: _____
Client Contact: _____

Attachments: _____

Meeting Name: _____
Meeting #: _____

Meeting Date: _____
Start Time: _____
End Time: _____
Timezone: _____
Meeting Location: _____

Scheduled Attendees:

Sample

4- FUNCTIONAL PERFORMANCE TESTING

	Agenda #	Meeting Origin	Title	Assignment	Due Date	Priority	Status	Old/New?
	4.1		General Safety Reminders	Keith Estey	5/1/2023	High	Closed	Old
	4.2		General Safety Reminders	Keith Estey	5/1/2023	High	Closed	Old
	4.3		General Safety Reminders	Keith Estey	5/1/2023	High	Closed	Old

PROJECT MANAGEMENT SYSTEM

EP Project No: _____
EP Project Title: _____
EP Project Manager: _____

Client Project No: _____
Client Name: _____
Client Contact: _____

Attachments: _____

Meeting Name: _____
Meeting #: _____

Meeting Date: _____
Start Time: _____
End Time: _____
Timezone: _____
Meeting Location: _____

Sample

Scheduled Attendees:

5- INTEGRATED SYSTEMS TESTING (CAN/ULC-S1001)

	Agenda #	Meeting Origin	Title	Assignment	Due Date	Priority	Status	Old/New?
	4.1		General Safety Reminders	Keith Estey	5/1/2023	High	Closed	Old
	4.2		General Safety Reminders	Keith Estey	5/1/2023	High	Closed	Old
	4.3		General Safety Reminders	Keith Estey	5/1/2023	High	Closed	Old

6- COMMISSIONING ISSUES LOG

	Agenda #	Meeting Origin	Title	Assignment	Due Date	Priority	Status	Old/New?
	6.1		General Safety Reminders	Keith Estey	5/1/2023	High	Closed	Old

PROJECT MANAGEMENT SYSTEM

EP Project No: _____
EP Project Title: _____
EP Project Manager: _____

Client Project No: _____
Client Name: _____
Client Contact: _____

Attachments: _____

Meeting Name: _____
Meeting #: _____

Meeting Date: _____
Start Time: _____
End Time: _____
Timezone: _____
Meeting Location: _____

Scheduled Attendees:

	6.2		General Safety Reminders	Keith Estey	5/1/2023	High	Closed	Old
	6.3		General Safety Reminders	Keith Estey	5/1/2023	High	Closed	Old

7- TRAINING

	Agenda #	Meeting Origin	Title	Assignment	Due Date	Priority	Status	Old/New?
	7.1		General Safety Reminders	Keith Estey	5/1/2023	High	Closed	Old
	7.2		General Safety Reminders	Keith Estey	5/1/2023	High	Closed	Old

Sample

PROJECT MANAGEMENT SYSTEM

EP Project No: _____
EP Project Title: _____
EP Project Manager: _____

Client Project No: _____
Client Name: _____
Client Contact: _____

Attachments: _____

Meeting Name: _____
Meeting #: _____

Meeting Date: _____
Start Time: _____
End Time: _____
Timezone: _____
Meeting Location: _____

Scheduled Attendees:

	7.3		General Safety Reminders	Keith Estey	5/1/2023	High	Closed	Old

8- GENERAL

	Agenda #	Meeting Origin	Title	Assignment	Due Date	Priority	Status	Old/New?
	8.1		General Safety Reminders	Keith Estey	5/1/2023	High	Closed	Old
	8.2		General Safety Reminders	Keith Estey	5/1/2023	High	Closed	Old
	8.3		General Safety Reminders	Keith Estey	5/1/2023	High	Closed	Old

Sample

EASTPOINT
ENGINEERING

PROJECT MANAGEMENT SYSTEM

EP Project No: _____
EP Project Title: _____
EP Project Manager: _____

Client Project No: _____
Client Name: _____
Client Contact: _____

Attachments: _____

Meeting Name: _____
Meeting #: _____

Meeting Date: _____
Start Time: _____
End Time: _____
Timezone: _____
Meeting Location: _____

Scheduled Attendees:

SHOULD ANY DISCREPANCIES OR INCONSISTENCIES BE NOTED, NOTIFY THE UNDERSIGNED IN WRITING WITHIN 5 (FIVE) WORKING DAYS OF RECEIVING THESE MINUTES. IF NO NOTIFICATIONS ARE RECEIVED AND/OR RECORDED, ALL SHALL DEEM THE MINUTES ACCEPTABLE.

MINUTES WRITTEN BY:

_____ _____ DATE: _____
(PRINTED - NAME & TITLE) (SIGNATURE)

Sample

Appendix C – Pre-Functional Testing Forms

Brookside Junior High Boiler Replacement - PFT Forms_R1

Sample

Boiler

Project / Equipment / School / Div. 23 HVAC

Boiler - Gas

Not Started

Design	Proposed	Final	Units

BOILER WORK

Sign-Off

When the assigned party (or parties) has verified that all items on the associated checklist have been completed, they are to sign/date this form.

Name:	Title/Role:	Company:	Date Completed:

Not Started
Assigned to Keith.Estey@eastpoint.ca
Created by Keith.Estey@eastpoint.ca on 3/20/2025 3:04:34 PM

Documentation

Documentation

Verify	Pass	Fail	N/A	Notes
Contractor to ensure correct equipment Manufacturer is installed.	☐	☐	☐	----
Contractor to ensure correct equipment Model is installed. (Attach picture of nameplate if accessible or fill in fields below)	☐	☐	☐	----
Installed equipment model number:	☐	☐	☐	----
Installed equipement serial number:	☐	☐	☐	----
Does the installed equipment match the requirements of the approved shop drawings and contract documents?	☐	☐	☐	----
Has the Installation and startup manual been provided?	☐	☐	☐	----
Have factory tests results been received and reviewed?	☐	☐	☐	----
----	☐	☐	☐	----

Sample

Not Started
Assigned to Keith.Estey@eastpoint.ca
Created by Keith.Estey@eastpoint.ca on 3/20/2025 3:05:45 PM

Pre-Functional Checklists

Mechanical - When contractor has verified all items on the pre-functional checklist, set overall status to 'Complete', indicating the system is ready for functional performance testing.

Verify	Pass	Fail	N/A	Notes
Unit is free from physical damage	☐	☐	☐	----
All components present and in proper order	☐	☐	☐	----
Unit tags affixed	☐	☐	☐	----
Unit secured as required by manufacturer and specifications	☐	☐	☐	----
Adequate clearance around unit for service	☐	☐	☐	----
All components accessible for maintenance	☐	☐	☐	----
Flue completely installed and properly sloped	☐	☐	☐	----
Unit labeled and is easy to see	☐	☐	☐	----
All piping components have been installed (in the correct order) as required by detail drawing. Blowdown system, makeup water piping and safety reliefs are installed.	☐	☐	☐	----
Piping arranged for ease of unit removal	☐	☐	☐	----
Piping supported as required by specifications	☐	☐	☐	----
Piping is clean	☐	☐	☐	----
Piping insulation is complete and installed as per specifications	☐	☐	☐	----
Thermometers and pressure gauges on supply and return lines	☐	☐	☐	----
All valves and test ports are easily accessible	☐	☐	☐	----
Valve tags attached	☐	☐	☐	----
Control panel accessible and labeled properly	☐	☐	☐	----
Test ports installed near all control sensors	☐	☐	☐	----
Actuators installed and calibration verified	☐	☐	☐	----
Seismic restraints in place, if applicable	☐	☐	☐	----
Test plugs (P/T) installed near all control sensors and as per spec	☐	☐	☐	----
Combustion air supply installed	☐	☐	☐	----
No leaking apparent	☐	☐	☐	----
Condensing boilers: both boiler and venting systems condensate piping are properly trapped and primed with acid water neutralization system.	☐	☐	☐	----
Room has adequate cooling for installed equipment	☐	☐	☐	----

Sample

Verify	Pass	Fail	N/A	Notes
Gas piping installed and tested	☐	☐	☐	----
Drip leg provided	☐	☐	☐	----
Gas cock valve orientation per manufacturers recommendations	☐	☐	☐	----
Gas cock valve accessible and travels freely	☐	☐	☐	----
Gas cock checked for leaks in closed position with the other gas train valves open	☐	☐	☐	----
Gas pressure adjusted and verified within acceptable range	☐	☐	☐	----
Gas pressure sensor limits are appropriate for application	☐	☐	☐	----
Any municipality inspections required are completed	☐	☐	☐	----
Piping type and flow direction labeled on piping	☐	☐	☐	----
Chemical treatment system or plan installed	☐	☐	☐	----
Unions installed to allow for easy removal of control valves	☐	☐	☐	----
Safeties installed and operational	☐	☐	☐	----
System flushed, filled, and air purged	☐	☐	☐	----
Burner adjusted to proper settings	☐	☐	☐	----
System starts and runs without any unusual noise or vibration	☐	☐	☐	----
CO2 and CO values from burner adjustment (ppm/ppm)	☐	☐	☐	----
Boiler settings (staging delays, dead bands, PID loops, firing rates and ramps, etc.) have been adjusted to achieve stable boiler operation and meeting of HHW temp set point without excessive over or undershoot or nuisance alarms	☐	☐	☐	----
All setting adjustments from original startup are documented and provided in the O&Ms and to the CxP	☐	☐	☐	----

Not Started
Assigned to Keith.Estey@eastpoint.ca
Created by Keith.Estey@eastpoint.ca on 3/20/2025 2:35:56 PM

Sample

Pre-Functional Checklists

Electrical - When contractor has verified all items on the pre-functional checklist, set overall status to 'Complete', indicating the system is ready for functional performance testing.

Verify	Pass	Fail	N/A	Notes
Local disconnect installed in accessible location	☐	☐	☐	----
All electrical connections are tight	☐	☐	☐	----
All electrical components are grounded	☐	☐	☐	----
Starter overload breakers installed and correct size	☐	☐	☐	----

Not Started
Assigned to Keith.Estey@eastpoint.ca
Created by Keith.Estey@eastpoint.ca on 3/20/2025 2:35:57 PM

Pre-Functional Checklists

Controls - When contractor has verified all items on the pre-functional checklist, set overall status to 'Complete', indicating the system is ready for functional performance testing.

Verify	Pass	Fail	N/A	Notes
Low water switch operational	☐	☐	☐	----
Temperature sensors operational and calibrated	☐	☐	☐	----
Unit operating sequence verified and correct	☐	☐	☐	----
All control devices and wiring complete	☐	☐	☐	----
Interlocks and communication to building automation system connected and functional, including start/stop, HW set point determination, pump speed control, pump rotation, isolation valve control, alarms, monitoring, etc.	☐	☐	☐	----
Multiple boiler interlocks (lead / lag / slave) completed	☐	☐	☐	----
Specified point-to-point checks have been completed and documentation record submitted for this system	☐	☐	☐	----
All points to be passed to BAS are mapped and confirmed to be working at the BAS	☐	☐	☐	----
All alarms specified to be passed to BAS are mapped and confirmed operational	☐	☐	☐	----
Remote start and stop verified	☐	☐	☐	----
Hot water temperature reset signal verified (if applicable)	☐	☐	☐	----
Piping gauges, BAS and associated panel temperature and pressure readouts match.	☐	☐	☐	----

Sample

Not Started
Assigned to Keith.Estey@eastpoint.ca
Created by Keith.Estey@eastpoint.ca on 3/20/2025 2:35:57 PM

Pre-Functional Checklists

Test and Balance - When contractor has verified all items on the pre-functional checklist, set overall status to 'Complete', indicating the system is ready for functional performance testing.

Verify	Pass	Fail	N/A	Notes
Water strainer is clean	☐	☐	☐	----
Pressure drop (ft)	☐	☐	☐	----
Heating water flow rate (gpm)	☐	☐	☐	----

Not Started
Assigned to Keith.Estey@eastpoint.ca
Created by Keith.Estey@eastpoint.ca on 3/20/2025 2:35:57 PM

Sample

Building Controls

Project / Equipment / School / Div. 23 HVAC

Building Automation System

Not Started

Design	Proposed	Final	Units

BUILDING CONTROLS WORK

Pre-Functional Checklists

Controls - When contractor has verified all items on the pre-functional checklist, set overall status to 'Complete', indicating the system is ready for functional performance testing. General Installation

Verify	Pass	Fail	N/A	Notes
General appearance good, no apparent damage	☐	☐	☐	----
Equipment labels affixed	☐	☐	☐	----
Layout and location of control panels match drawings	☐	☐	☐	----
Areas or equipment panels served is noted in a coherent manner in control drawings	☐	☐	☐	----
Wiring labeled inside panels (to controlled components)	☐	☐	☐	----
Controlled components labeled/tagged	☐	☐	☐	----
BAS connection made to labeled terminal(s) as shown on drawings	☐	☐	☐	----
Shielded wiring used on electronic sensors as needed per device and equipment manufacturer's specifications.	☐	☐	☐	----
110 volt AC power available to panels	☐	☐	☐	----
Battery backup in place and operable for all controllers impacting fire / life / safety and other critical equipment and interfaces	☐	☐	☐	----
Surge suppression in place and operable where applicable.	☐	☐	☐	----
Panels properly grounded	☐	☐	☐	----
System date and time correct	☐	☐	☐	----
All equipment controlled or monitored are shown on one or more graphic screens.	☐	☐	☐	----
Site plan links from site to building screens	☐	☐	☐	----
Floor plan links to equipment screen	☐	☐	☐	----
Mechanical room links from equipment in room to equipment only screen	☐	☐	☐	----
Temperature range colors on floor plans, when required	☐	☐	☐	----
All alarm notifications on screens	☐	☐	☐	----
All user adjustable set points and schedules are operable directly from the interface (not just in programming screens)	☐	☐	☐	----

Sample

Verify	Pass	Fail	N/A	Notes
All controlled or monitored points shown on each equipment screen in proper location.	☐	☐	☐	----
All controlled or monitored points shown have been checked to be linked to the proper database point.	☐	☐	☐	----
Motion and color features indicating run, stop or alarm status working properly.	☐	☐	☐	----
Links to the sequences of operation functioning.	☐	☐	☐	----
Each screen shows the OAT, OAH, date and time of day.	☐	☐	☐	----
Each equipment is labeled with equipment schedule ID tag.	☐	☐	☐	----
Graphics complete per owner approved drafts	☐	☐	☐	----
Interfaces and integration to packaged and 3rd party equipment / systems is complete and functioning per specifications.	☐	☐	☐	----
Ethernet network cable is CAT-5E/6/6A - Per specification	☐	☐	☐	----
Control wiring in conduit if required per plans/spec	☐	☐	☐	----
All serial comm. cable is shielded-twisted pair, or meets manufacturer's specified requirements	☐	☐	☐	----
Serial comm. terminating resistors installed as required	☐	☐	☐	----
Serial comm. integrity checked with oscilloscope (as required)	☐	☐	☐	----
----	☐	☐	☐	----

Not Started
Assigned to Keith.Estey@eastpoint.ca
Created by Keith.Estey@eastpoint.ca on 4/7/2025 5:43:48 PM

Sample

Sign-Off

When the assigned party (or parties) has verified that all items on the associated checklist have been completed, they are to sign/date this form.

Name:	Title/Role:	Company:	Date Completed:
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Not Started
Assigned to Keith.Estey@eastpoint.ca
Created by Keith.Estey@eastpoint.ca on 4/7/2025 5:44:06 PM

DHW tank

Project / Equipment / School / Div. 23 HVAC

DHW Tank - Electric

Not Started

Design	Proposed	Final	Units

DHW TANK WORK

Sign-Off

When the assigned party (or parties) has verified that all items on the associated checklist have been completed, they are to sign/date this form.

Name:	Title/Role:	Company:	Date Completed:

Not Started

Assigned to Keith.Estey@eastpoint.ca
Created by Keith.Estey@eastpoint.ca on 3/20/2025 3:04:34 PM

Documentation

Documentation

Verify	Pass	Fail	N/A	Notes
Contractor to ensure correct equipment Manufacturer is installed.	☐	☐	☐	----
Contractor to ensure correct equipment Model is installed. (Attach picture of nameplate if accessible or fill in fields below)	☐	☐	☐	----
Installed equipment model number:	☐	☐	☐	----
Installed equipement serial number:	☐	☐	☐	----
Does the installed equipment match the requirements of the approved shop drawings and contract documents?	☐	☐	☐	----
Has the Installation and startup manual been provided?	☐	☐	☐	----
Have factory tests results been received and reviewed?	☐	☐	☐	----
----	☐	☐	☐	----

Sample

Not Started
Assigned to Keith.Estey@eastpoint.ca
Created by Keith.Estey@eastpoint.ca on 3/20/2025 3:05:48 PM

Pre-Functional Checklists

Mechanical Contractor - Once pre-functional testing checklist is complet...

Verify	Pass	Fail	N/A	Notes
Sufficient access and service space.	☐	☐	☐	----
Piping is installed correctly as per schematics and detailed drawings.	☐	☐	☐	----
Di-Electric connections provided.	☐	☐	☐	----
Thermometers (Inlet / Outlet) are installed as required.	☐	☐	☐	----
Drain valve is installed.	☐	☐	☐	----
Temperature and pressure relief valve installed and piped to floor drain. Note pressure relief valve rating.	☐	☐	☐	----
Isolation valves installed to accommodate service & maintenance.	☐	☐	☐	----
Mixing valve installed as per details, drawings, and specifications.	☐	☐	☐	----
Tank insulation installed as per the details, drawings and specifications.	☐	☐	☐	----
Additional storage tank(s) installed as per drawing details.	☐	☐	☐	----

Not Started
Assigned to Keith.Estey@eastpoint.ca
Created by Keith.Estey@eastpoint.ca on 3/20/2025 2:44:25 PM

Pre-Functional Checklists

Electrical - When contractor has verified all items on the pre-functional checklist, set overall status to 'Complete', indicating the system is ready for functional performance testing.

Verify	Pass	Fail	N/A	Notes
All electrical connections are tight.	☐	☐	☐	----
All electrical components are grounded.	☐	☐	☐	----
Disconnect provided and installed in accessible location in proper proximity to the equipment.	☐	☐	☐	----

Not Started
Assigned to Keith.Estey@eastpoint.ca
Created by Keith.Estey@eastpoint.ca on 3/20/2025 2:44:25 PM

Pre-Functional Checklists

Sample

Brookside Junior High Boiler Replacement - PFT Forms_R1

Controls - When contractor has verified all items on the pre-functional checklist, set overall status to 'Complete', indicating the system is ready for functional performance testing.

Verify	Pass	Fail	N/A	Notes
Equipment labelled is shown in the BAS	☐	☐	☐	----
Specified control and safety features in place and operable	☐	☐	☐	----
Control system interlocks and monitoring connected and functional	☐	☐	☐	----
Point-to-point checks have been completed and documentation submitted	☐	☐	☐	----
Specified sequences of operation and operating schedules have been implemented and tested	☐	☐	☐	----

Not Started

Assigned to Keith.Estey@eastpoint.ca

Created by Keith.Estey@eastpoint.ca on 3/20/2025 2:44:25 PM

Sample

Heating Piping

Project / Equipment / School / Div. 23 HVAC

Heating Water Piping

Not Started

Design	Proposed	Final	Units

HEATING PIPING WORK

Sign-Off

When the assigned party (or parties) has verified that all items on the associated checklist have been completed, they are to sign/date this form.

Name:	Title/Role:	Company:	Date Completed:

Not Started

Assigned to Keith.Estey@eastpoint.ca
Created by Keith.Estey@eastpoint.ca on 3/20/2025 3:04:35 PM

Documentation

Documentation

Verify	Pass	Fail	N/A	Notes
Contractor to ensure correct equipment Manufacturer is installed.	☐	☐	☐	----
Contractor to ensure correct equipment Model is installed. (Attach picture of nameplate if accessible or fill in fields below)	☐	☐	☐	----
Installed equipment model number:	☐	☐	☐	----
Installed equipement serial number:	☐	☐	☐	----
Does the installed equipment match the requirements of the approved shop drawings and contract documents?	☐	☐	☐	----
Has the Installation and startup manual been provided?	☐	☐	☐	----
Have factory tests results been received and reviewed?	☐	☐	☐	----
----	☐	☐	☐	----

Sample

Not Started
Assigned to Keith.Estey@eastpoint.ca
Created by Keith.Estey@eastpoint.ca on 3/20/2025 3:05:49 PM

Pre-Functional Checklists

Mechanical - When contractor has verified all items on the pre-functional checklist, set overall status to 'Complete', indicating the system is ready for functional performance testing.

Verify	Pass	Fail	N/A	Notes
Piping is clean and free of damage prior to installation.	☐	☐	☐	----
Piping is free to expand and contract without noise or damage to hangers, joints, or the building.	☐	☐	☐	----
Piping is installed with sufficient pitch and arranged in a manner to ensure drainage and venting of the entire system.	☐	☐	☐	----
Manual air vents are provided at high points in closed water systems.	☐	☐	☐	----
Changes in pipe sizes are made with the proper size reducing fittings, reducing fittings, reducing elbow or reducing tees. Bushings are not allowed.	☐	☐	☐	----
All piping supports and hangers meet criteria set in the construction documents.	☐	☐	☐	----
All fittings meet specification requirements.	☐	☐	☐	----
All equipment requiring maintenance is accessible (valves, junction boxes, etc.).	☐	☐	☐	----
Piping does not block access to equipment that is part of this system or another system (e.g., air terminal units).	☐	☐	☐	----
Piping is installed in a manner to ensure that insulation will not contact adjacent surfaces.	☐	☐	☐	----
All pipe openings are temporarily sealed to maintain piping system cleanliness.	☐	☐	☐	----
Record drawings have been updated to reflect any changes made.	☐	☐	☐	----
Nipples are made of the same material as the pipe.	☐	☐	☐	----
Connections between copper and steel pipes are made with dielectric fittings.	☐	☐	☐	----
A union is provided ahead of each screwed valve, trap, or strainer, and on each side of each piece of equipment and whatever needed to dismantle piping.	☐	☐	☐	----
Mechanical coupling if used is only used for piping and locations as described in the construction documents.	☐	☐	☐	----
The chilled water system is installed with high pressure fittings, flanges and unions.	☐	☐	☐	----
Auxiliary drain valves are provided at all low points in hose bib piping to facilitate seasonal draining.	☐	☐	☐	----
Strainers and low-point drains opened and verified to be clean	☐	☐	☐	----
Construction strainers removed	☐	☐	☐	----
Test plugs (P/T) installed near all control sensors and as per spec	☐	☐	☐	----
Piping system properly flushed and cleaned and temporary piping removed	☐	☐	☐	----
Piping pressure tested according to contract documents	☐	☐	☐	----
Chemical treatment system or plan installed	☐	☐	☐	----
ASME pressure vessel data sheet or certification tag posted and inspection complete for each expansion tank	☐	☐	☐	----

Sample

Verify	Pass	Fail	N/A	Notes
Expansion tanks verified to not be air bound and system completely full of water. System completed purged of air	☐	☐	☐	----
Air vents and bleeds at high points of systems functional	☐	☐	☐	----
Isolation valves provided at all branches and main takeoffs to facilitate isolation (as required by contract)	☐	☐	☐	----
Valve installation per manufacturer's instructions	☐	☐	☐	----
Valve manufacturer labels permanently affixed	☐	☐	☐	----
Manual isolation valves checked for proper seal and found to travel freely	☐	☐	☐	----
Valves installed in proper direction	☐	☐	☐	----
Valves stroke fully and easily and spanning is calibrated (see calibration section below)	☐	☐	☐	----
Valves that require a positive shut-off are verified to not be leaking when closed at normal operating pressure	☐	☐	☐	----
No leaking apparent	☐	☐	☐	----
Valves tagged and valve schedule submitted and displayed as required	☐	☐	☐	----
Chains and extended handles for valve actuation provided per specifications.	☐	☐	☐	----
Installation of system and balancing devices allowed balancing to be completed following specified NEBB or AABC procedures and contract documents	☐	☐	☐	----
----	☐	☐	☐	----

Not Started
Assigned to Keith.Estey@eastpoint.ca
Created by Keith.Estey@eastpoint.ca on 3/20/2025 2:46:00 PM

Sample

Propane Storage Tank

Project / Equipment / School / Div. 23 HVAC

Tank - Fuel Storage

Not Started

Design	Proposed	Final	Units

PROPANE STORAGE TANK WORK

Pre-Functional Checklists

Controls - When contractor has verified all items on the pre-functional, change work status from "In-progress" to "Complete".

Verify:	Pass	Fail	N/A	Notes
Sensors /alarms tied into BAS and verified correct operation, if applicable.	☐	☐	☐	----

Not Started
Assigned to Keith.Estey@eastpoint.ca
Created by Keith.Estey@eastpoint.ca on 3/20/2025 2:47:28 PM

Sign-Off

When the assigned party (or parties) has verified that all items on the associated checklist have been completed, they are to sign/date this form.

Name:	Title/Role:	Company:	Date Completed:

Not Started
Assigned to Keith.Estey@eastpoint.ca
Created by Keith.Estey@eastpoint.ca on 3/20/2025 3:04:35 PM

Documentation

Documentation

Verify	Pass	Fail	N/A	Notes
Contractor to ensure correct equipment Manufacturer is installed.	☐	☐	☐	----

Sample

Verify	Pass	Fail	N/A	Notes
Contractor to ensure correct equipment Model is installed. (Attach picture of nameplate if accessible or fill in fields below)	☐	☐	☐	----
Installed equipment model number:	☐	☐	☐	----
Installed equipement serial number:	☐	☐	☐	----
Does the installed equipment match the requirements of the approved shop drawings and contract documents?	☐	☐	☐	----
Has the Installation and startup manual been provided?	☐	☐	☐	----
Have factory tests results been received and reviewed?	☐	☐	☐	----
----	☐	☐	☐	----

Not Started
Assigned to Keith.Estey@eastpoint.ca
Created by Keith.Estey@eastpoint.ca on 3/20/2025 3:05:49 PM

Sample

Pre-Functional Checklists

Installing contract - Once pre-functional testing checklist is completed, change checklist from in-progress to complete

Verify	Pass	Fail	N/A	Notes
Tank level and secure.	☐	☐	☐	----
Primary and secondary emergency venting installed	☐	☐	☐	----
Fuel piping installed complete with flexiable connects to the tank.	☐	☐	☐	----
Levelometer installed.	☐	☐	☐	----
Leak alam installed.	☐	☐	☐	----
Fuel spill box installed.	☐	☐	☐	----
Overfill sensors and alarms installed and tested, as specified.	☐	☐	☐	----
----	☐	☐	☐	----

Not Started
Assigned to Keith.Estey@eastpoint.ca
Created by Keith.Estey@eastpoint.ca on 3/20/2025 2:47:28 PM

Pump

Project / Equipment / School / Div. 23 HVAC

Pumps

Not Started

Design	Proposed	Final	Units

PUMP WORK

Sign-Off

When the assigned party (or parties) has verified that all items on the associated checklist have been completed, they are to sign/date this form.

Name:	Title/Role:	Company:	Date Completed:

Not Started

Assigned to Keith.Estey@eastpoint.ca
Created by Keith.Estey@eastpoint.ca on 3/20/2025 3:04:35 PM

Documentation

Documentation

Verify	Pass	Fail	N/A	Notes
Contractor to ensure correct equipment Manufacturer is installed.	☐	☐	☐	----
Contractor to ensure correct equipment Model is installed. (Attach picture of nameplate if accessible or fill in fields below)	☐	☐	☐	----
Installed equipment model number:	☐	☐	☐	----
Installed equipement serial number:	☐	☐	☐	----
Does the installed equipment match the requirements of the approved shop drawings and contract documents?	☐	☐	☐	----
Has the Installation and startup manual been provided?	☐	☐	☐	----
Have factory tests results been received and reviewed?	☐	☐	☐	----
----	☐	☐	☐	----

Sample

Not Started
Assigned to Keith.Estey@eastpoint.ca
Created by Keith.Estey@eastpoint.ca on 3/20/2025 3:05:49 PM

Pre-Functional Checklists

Mechanical - When contractor has verified all items on the pre-functional checklist, set overall status to 'Complete', indicating the system is ready for functional performance testing.

Verify	Pass	Fail	N/A	Notes
Unit is free from physical damage.	☐	☐	☐	----
All components present as identified in pump detail and specifications, or approved equivalents (e.g. isolation valves, suction diffusers, triple duty valve, pressure gauges, etc.).	☐	☐	☐	----
Unit tags affixed.	☐	☐	☐	----
Manufacturer's ratings readable/accurate.	☐	☐	☐	----
Unit secured and mounted as required by manufacturer, details, and specifications.	☐	☐	☐	----
Adequate clearance around unit for service.	☐	☐	☐	----
All components accessible for maintenance.	☐	☐	☐	----
Unit can be removed from building.	☐	☐	☐	----
Unit labeled and is easy to see.	☐	☐	☐	----
Piping arranged for ease of unit removal.	☐	☐	☐	----
Piping supported as required by specifications.	☐	☐	☐	----
Piping is clean.	☐	☐	☐	----
Piping insulation complete and installed as per specifications.	☐	☐	☐	----
All valves and test ports are easily accessible.	☐	☐	☐	----
Valve tags attached, if required.	☐	☐	☐	----
Unit checked, aligned, and certified prior to startup and report submitted.	☐	☐	☐	----
Unit and motor lubricated before startup.	☐	☐	☐	----
Pump shaft rotates easily with power turned off.	☐	☐	☐	----
System starts and runs without any unusual noise or vibration.	☐	☐	☐	----
Seismic anchoring installed and functional, if applicable.	☐	☐	☐	----

Sample

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Pre-Functional Checklists

Test and Balance - When contractor has verified all items on the pre-functional checklist, set overall status to 'Complete', indicating the system is ready for functional performance testing.

Verify	Pass	Fail	N/A	Notes
Flow Rate, gpm.	☐	☐	☐	----
Inlet pressure (ft) / Outlet pressure (ft).	☐	☐	☐	----
Motor rotation in the proper direction.	☐	☐	☐	----
Start-up strainer removed (after 24 hours).	☐	☐	☐	----

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Pre-Functional Checklists

Electrical - When contractor has verified all items on the pre-functional checklist, set overall status to 'Complete', indicating the system is ready for functional performance testing.

Verify	Pass	Fail	N/A	Notes
All electrical connections are tight.	☐	☐	☐	----
All electrical components are grounded.	☐	☐	☐	----
Safety disconnect installed in an accessible location.	☐	☐	☐	----
Motor overload verified.	☐	☐	☐	----
Motor voltage and amps verified - each phase.	☐	☐	☐	----

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Pre-Functional Checklists

Controls - When contractor has verified all items on the pre-functional checklist, set overall status to 'Complete', indicating the system is ready for functional performance testing. General Installation

Verify	Pass	Fail	N/A	Notes
General appearance is good, no phsyical damage to equipment.	☐	☐	☐	----
Equipment labels affixed.	☐	☐	☐	----
Wiring labeled inside panels for this piece of euqiupment.	☐	☐	☐	----
Controlled components for this piece of equipment, labeled/tagged.	☐	☐	☐	----
BAS connection made to labeled terminal(s) as shown on contract documents, as applicable.	☐	☐	☐	----
Shielded wiring used on electronic sensors as needed per device and equipment manufacturer's specifications.	☐	☐	☐	----

Sample

Verify	Pass	Fail	N/A	Notes
Equipment alarms are programmed within the graphics, as specified.	☐	☐	☐	----
All user adjustable set points and schedules are operable directly from the interface for this piece of equipment (not just in programming screens).	☐	☐	☐	----
Graphics complete per owner approved drafts for this piece of equipment.	☐	☐	☐	----
Integration with other equipment is complete, tested, and points are verified as per specifications.	☐	☐	☐	----
----	☐	☐	☐	----

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Sample

VRF - Heat Pump

Project / Equipment / School / Div. 23 HVAC

VRF System

Not Started

Design	Proposed	Final	Units

VRF - HEAT PUMP WORK

Sign-Off

When the assigned party (or parties) has verified that all items on the associated checklist have been completed, they are to sign/date this form.

Name:	Title/Role:	Company:	Date Completed:

Not Started

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Documentation

Documentation

Verify	Pass	Fail	N/A	Notes
Contractor to ensure correct equipment Manufacturer is installed.	☐	☐	☐	----
Contractor to ensure correct equipment Model is installed. (Attach picture of nameplate if accessible or fill in fields below)	☐	☐	☐	----
Installed equipment model number:	☐	☐	☐	----
Installed equipement serial number:	☐	☐	☐	----
Does the installed equipment match the requirements of the approved shop drawings and contract documents?	☐	☐	☐	----
Has the Installation and startup manual been provided?	☐	☐	☐	----
Have factory tests results been received and reviewed?	☐	☐	☐	----
----	☐	☐	☐	----

Sample

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Pre-Functional Checklists

Verify the following

Outdoor Unit:

Verify	Pass	Fail	N/A	Notes
Permanent labels affixed.	☐	☐	☐	----
Installed flat, level & secured.	☐	☐	☐	----
Casing condition good: no dents, cracks, access door properly functional.	☐	☐	☐	----
Maintenance access acceptable for unit and components.	☐	☐	☐	----
Clean up of equipment completed.	☐	☐	☐	----
Refrigerant lines are installed with the allowable length and height differences.	☐	☐	☐	----
Refrigerant piping pressure tested and report submitted.	☐	☐	☐	----
Thermal insulation properly installed and as specified.	☐	☐	☐	----
Crankcase heater on when unit is off (if applicable).	☐	☐	☐	----
Condenser coils clean and in good condition (air cooled).	☐	☐	☐	----
Adequate clearance for airflow around condenser.	☐	☐	☐	----
Dedicated controls provided and installed as per drawings and specifications, if applicable.	☐	☐	☐	----
Controls operational as specified.	☐	☐	☐	----

Multiport Distribution Controller (MDC):

Verify	Pass	Fail	N/A	Notes
Unit is located in an area where the operating sound will not be objectionable.	☐	☐	☐	----
Unit is hanging in the horizontal position.	☐	☐	☐	----
Permanent labels affixed.	☐	☐	☐	----
Casing condition good: no dents, cracks, access door properly functional.	☐	☐	☐	----
Maintenance access acceptable per manufacturer recommendations.	☐	☐	☐	----
The field installed refrigerant line sizes and lengths are correct, and installation matches manufacturer's requirements.	☐	☐	☐	----
Brazing process followed manufacturer's requirements.	☐	☐	☐	----
Condensate drain is connected.	☐	☐	☐	----

Indoor Units:

Sample

Verify	Pass	Fail	N/A	Notes
All indoor unit locations have been verified by Model/Side and site plans.	☐	☐	☐	----
All units are mounted and secured per their installation requirements.	☐	☐	☐	----
All indoor units are level.	☐	☐	☐	----
All Y branch joints are installed per manufacturer requirements.	☐	☐	☐	----
Leak check has been completed on refrigerant piping.	☐	☐	☐	----
All refrigeration piping was evacuated and charged per manufacturer requirements.	☐	☐	☐	----
All refrigerant lines are insulated individually.	☐	☐	☐	----
All condensate drain lines are insulated, checked for leaks, are clean, and slope to drain as specified.	☐	☐	☐	----
Filters installed and clean.	☐	☐	☐	----

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Pre-Functional Checklists

Electrical Contractor - when the pre-functional checklists are complete, change status from in-progress to complete

VERIFY	Pass	Fail	N/A	Notes
Power disconnects in place and labeled.	☐	☐	☐	----
All electric connections tight.	☐	☐	☐	----
Proper grounding installed for components and unit.	☐	☐	☐	----

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Pre-Functional Checklists

Controls - When contractor has verified all items on the pre-functional checklist, set overall status to 'Complete', indicating the system is ready for functional performance testing.

Verify	Pass	Fail	N/A	Notes
Room thermostats installed and calibration verified.	☐	☐	☐	----
VRF system sequence of control (heating/cooling) verified.	☐	☐	☐	----

Sample

Brookside Junior High Boiler Replacement - PFT Forms_R1

Not Started

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Sample

Appendix D – Functional Performance Testing Procedures

Functional Performance Testing Form_Template

Sample

EastPoint Cx Template V1

Project

PROJECT WORK

Functional Performance Testing

1. Preparation

1a. Participants

Description	Notes
Enter all participants (Party & Participation)	----
Enter Party filling out this form & witnessing.	----
Enter Date of Test	----

1b. Pre-Requisite Checklist

Description	Pass	Fail	N/A	Notes
All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules with debugging, loop tuning and sensor calibrations completed.	☐	☐	☐	----
(a) Verbal Confirmation from Controls Contractor	☐	☐	☐	----
(b) Date Confirmed	☐	☐	☐	----
Duct cleaning complete and required reports approved.	☐	☐	☐	----
Piping system flushing complete and required reports approved.	☐	☐	☐	----
Duct and pipe pressure testing complete and required reports approved.	☐	☐	☐	----
Water treatment system complete and operational.	☐	☐	☐	----
Test and balance (TAB) completed and approved for the Air, Hydronic, and VAV terminal units connected.	☐	☐	☐	----
Panel schedules are accurate.	☐	☐	☐	----
Electrical short-circuit, arc flash, & coordination study reviewed	☐	☐	☐	----
All commissioning and design issues for this equipment corrected.	☐	☐	☐	----
These functional test procedures reviewed and approved by installing contractor and designer.	☐	☐	☐	----
Safeties and operating ranges reviewed.	☐	☐	☐	----
Test requirements and sequences of operation attached.	☐	☐	☐	----
Equipment is properly labelled.	☐	☐	☐	----
Schedules and setpoints attached (record current values and reset following testing).	☐	☐	☐	----

Sample

Description	Pass	Fail	N/A	Notes
False loading equipment, system and procedures ready (boilers, preheat or reheat coils, control loops, over-ride on OSA dampers, etc.)	☐	☐	☐	----
Have all energy savings control strategies, setpoints and schedules been incorporated that this equipment and control system are capable of? If not, list recommendations in notes.	☐	☐	☐	----
Control Program Review. Review the software control program(s) for this equipment. Parameters, setpoints and logic sequences appear to follow the specified written sequences.	☐	☐	☐	----
Has Point Verification Report been submitted? If So, What is the name of the Controls Contractor?	☐	☐	☐	----
The following have been started up and startup reports and pre-functional checklists submitted and approved ready for functional testing: (insert associated equipment and systems).	☐	☐	☐	----
Miscellaneous site checks of the pre-functional checklist and startup reports completed successfully.	☐	☐	☐	----
Sampling rates have been defined (if applicable).	☐	☐	☐	----

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Sample

Functional Performance Testing

2. Calibration Checks

2a. Sensor Calibration Checks

Sensor ID	Associated Equipment	Location Ok? (Y/N)	1st Gauge or EMCS Value	Instr. Measured Value	Final Gauge or EMCS Value	Pass	Fail	Notes
----	----	----	----	----	----	☐	☐	----
----	----	----	----	----	----	☐	☐	----
----	----	----	----	----	----	☐	☐	----
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----	----	----	----	----	----	☐	☐	----
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----	----	----	----	----	----	☐	☐	----
----	----	----	----	----	----	☐	☐	----
----	----	----	----	----	----	☐	☐	----

Sensor ID	Associated Equipment	Location Ok? (Y/N)	1st Gauge or EMCS Value	Instr. Measured Value	Final Gauge or EMCS Value	Pass	Fail	Notes
----	----	----	----	----	----	☐	☐	----

2b. Device Calibration Checks

Device or Actuator ID	Associated Equipment	Procedure / State	1st EMCS Value	Site Observation	Final EMCS Reading	Pass	Fail	Notes
----	----	----	----	----	----	☐	☐	----
----	----	----	----	----	----	☐	☐	----
----	----	----	----	----	----	☐	☐	----
----	----	----	----	----	----	☐	☐	----
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----	----	----	----	----	----	☐	☐	----
----	----	----	----	----	----	☐	☐	----

Sample

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Functional Performance Testing

3. Sequence of Operation Review

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Appendix E – Commissioning Issues Log

Commissioning Issues Log

Date: 5:41 PM

Revision: 0

Project: 0

Building: 0

Distribution: **Owner's Representative -**

No. of Resolved Issues: 0

No. of Issues Un Resolved: 0 **Total Items:** 0

OP - Open, indicates a resolution has not been agreed upon.
CL - Closed indicates that the resolution was verified to be incorporated.
IP - In Process indicates resolution agreed upon, but still to be confirmed in next design package.
CL+ - Issue closed, though recommendations were not incorporated.
IP+ - indicates In Progress, but needs additional discussion.

Legend

CxA – Commissioning Agent
OWN - Owner
ARCH - Architect
MD - Mechanical HVAC Designer
PD - Plumbing Designer
ED - Electrical Designer
CD - Controls Designer
FPD - Fire Protection Designer
SD - Security Designer
PCM - Prime Consultant
MC - Mechanical Contractor
PC - Plumbing Contractor
EC - Electrical Contractor
CC - Controls Contractor
FPC - Fire Protection Contractor
SC - Security Contractor

Issue ID	Project Stage	Dwg/Spec #	Equipment / System / Location	Action Required By	Originator Of Issue	Originator Initials	Deficiency/ Issue Description	Date Issued (MM/DD/YY)	Status	Date Resolved (MM/DD/YY)	Comments / Owner and CxA Reply	Reviewer Intitals

Sample

Appendix F – Training Plan

OVERALL TRAINING and DEMONSTRATION PLAN and RECORD

Date: _____

Project:

Prepared By: _____

Reference: BCxA - Resources (2023)

Agenda #	Equipment/System (all trainings include equip, on-board ctrls and BAS ctrls)	Spec Section	Total Hrs [7]	Scope Code [5]	Audience [6]	Trainers' Companies	Hrs of Video	Agenda Sent?	Training Date(s)	Training Satisfactorily Complete
	Mechanical									
1	Heating water system (boiler, piping, pumps, storage, etc.)									
2	Ventilation (ERV, ductwork, etc.)									
3	Building Controsl									
	Electrical									
1	Disconnect Switches / Starters									
	TOTAL ALL DISCIPLINES	**TOTAL**								

Sample

EASTPOINT

Project Name: _____
Project Number: _____
System: _____
Commissioning Authority: _____
Company Name of Trainer(s): _____

Commissioning Training Check Sheet

Required Training Topics

		General Purpose of System (design intent)	Review of facility and occupancy profile	Functional Requirements	System philosophy, limitations of systems and emergency procedures	Review of system layout, equipment, components and controls	Equipment and system start-up, operation, monitoring, servicing, maintenance and shut-down procedures	System operating sequences, including start up, shut-down, oepration, adjustment of controls and emergency procedures	Maintenance and servicing	Troubleshooting diagnosis	Interaction among systems during integrated operation	Review of O&M documentation	OTHER TOPICS	Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at scheduled times, at the designated location	Instruct personnel in all phases of O&M using O&M Manuals as the basis of instruction	Review Contents of O&M in detail to explain all aspects of O&M. Insert additional data when the need is apparent	Total Hours	
Required Hours																		
Name of Trainee	**Company Name**	**Checkmark Box If Completed**																**Signature and Date**

Sample

By signing this document, I _____ declare that all training topics listed in the table have been addressed and that the information in the table is accurate.
Name of Trainer(s)

Page: _____ OF _____ Signed: _____ Date: _____

Part 1 General

1.1 SUMMARY OF SECTION

.1 Commissioning forms to be completed for equipment, system, and integrated system.

1.2 RELATED SECTIONS

.1 Section 01 91 13 - General Commissioning Requirements.

.2 Section 01 91 31 - Commissioning Plan.

.3 Section 01 91 41 - Commissioning Training Requirements.

.4 Requirements identified in product/system specification sections.

1.3 PRICE AND PAYMENT PROCEDURES

.1 Include the following data:

.1 Product manufacturer's installation instructions and recommended checks.

.2 Special procedures as specified in relevant technical sections.

.3 Items considered good installation and engineering industry practices deemed appropriate for proper and efficient operation.

.2 Equipment manufacturer's installation/start-up check lists are acceptable for use. If manufacturer’s installation/start-up checklist is to be used, provided to CxA and Designer to review and approve

.3 Use check lists for equipment installation. Document checklist verifying checks have been made, indicate deficiencies and corrective action taken.

.4 Installer to sign check lists upon completion, certifying stated checks and inspections have been performed. Return completed check lists to HRCE Representative for inclusion in final commissioning plan at completion of project.

1.4 COMMISSIONING FORMS

.1 CxA will develop forms and provide to Contractor required project-specific Commissioning plan/check list/forms, see draft commissioning plan for samples.

.2 When Commissioning forms are completed, notify CxA to allow for review for completeness.

.3 Use Commissioning forms to verify installation and record performance when starting equipment and systems.

.4 Strategy for Use:

.1 Contractor will provide required shop drawings information and verify correct installation and operation of items indicated on these forms.

.2 Confirm operation as per design criteria and intent.

.3 Identify variances between design and operation and reasons for variances.

.4 Verify operation in specified normal and emergency modes and under specified load conditions.

.5 Record analytical and substantiating data.

.6 Verified reported results.

.7 Form to bear signatures of recording technician.

.8 Reported results in true measured SI unit values.

.9 Maintain copy on site during start-up, testing, and commissioning period.

1.5 EXAMPLE FORMS

.1 The appended forms found in the Draft Commissioning Plan are examples and show what type of information is expected to be filled out and provided when completing these forms.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 This Section specifies roles and responsibilities of Commissioning Training.

.2 Related Requirements

.1 Section 01 91 13 - General Commissioning Requirements.

.2 Section 01 91 31 - Commissioning Plan.

.3 Section 01 91 33 - Commissioning Forms.

.4 Requirements Identified in Product/System Specification Sections.

1.2 TRAINEES

.1 Trainees: personnel selected for operating and maintaining this facility. This includes building operators, maintenance staff, security staff, key staff, and technical specialists as required.

.2 Trainees will be available for training during later stages of construction for purposes of familiarization with systems.

1.3 INSTRUCTOR

.1 Contractor and certified factory-trained manufacturers' personnel: to provide instruction on the following:

.1 Start-up, operation, and shut-down of equipment, components, and systems.

.2 Control features, reasons for, results of, implications on associated systems of, and adjustment of set points of control and safety devices.

.3 Instructions on servicing, maintenance, and adjustment of systems, equipment, and components.

.2 Contractor and equipment manufacturer to provide instruction on:

.1 Start-up, operation, maintenance, and shut-down of equipment they have certified installation, started up, and carried out Functional Performance Tests.

1.4 TRAINING OBJECTIVES

.1 Training to be detailed and duration to ensure:

.1 Safe, reliable, cost-effective, and energy-efficient operation of systems in normal and emergency modes under all conditions.

.2 Effective on-going inspection and measurements of system performance.

.3 Proper preventive maintenance, diagnosis, and trouble-shooting.

.4 Ability to update documentation.

.5 Ability to operate equipment and systems under emergency conditions until appropriate qualified assistance arrives

1.5 TRAINING MATERIALS

.1 Instructors to be responsible for content and quality.

.2 Contractor to be responsible for logging all training material.

.3 Training materials to include:

.1 "As-Built" Contract Documents.

.2 Operating Manual.

.3 Maintenance Manual.

.4 TAB and FPT Reports (Commissioning Issues Log).

.4 Training materials shall be provided in an electronic format that permits future training procedures to same degree of detail.

.5 Supplemental training materials may include:

.1 Multimedia presentations.

.2 Manufacturer's training videos.

.3 Equipment makes and models.

.6 Scheduling:

.1 Include a detailed training schedule within the Commissioning Schedule.

.2 Deliver system level training for commissioned equipment during regular working hours. If training duration is not outlined in specific specifications for commissioned system, one training sessions is to be provided and is to be no more than 3 (three) hours in length.

.3 Primary training to be completed prior to project acceptance.

.7 Responsibilities:

.1 Be responsible for:

.1 Implementation of training activities.

.2 Coordination among instructors.

.8 Training Content:

.1 Primary training to include demonstrations by Instructors using the installed equipment and systems.

.2 Content includes:

.1 Review of facility and occupancy profile.

.2 Functional requirements.

.3 System philosophy, limitations of systems, and emergency procedures.

.4 Review of system layout, equipment, components, and controls.

.5 Equipment and system start-up, operation, monitoring, servicing, maintenance, and shut-down procedures.

.6 System operating sequences, including step-by-step directions for starting up, shut-down, operation of valves, dampers, switches, adjustment of control settings, and emergency procedures.

.7 Maintenance and servicing.

.8 Troubleshooting diagnosis.

.9 Interaction among systems during integrated operation.

.10 Review of O&M documentation.

.3 Provide specialized training as specified in relevant Technical Sections of the construction specifications.

.9 Language:

.1 All training materials and sessions to be provided in English.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 This Section includes requirements for removal of underground fuel storage tanks, liquid, and associated work, including soil removal as indicated on Drawings; restoration of excavated area with new materials to match adjacent (existing) surfaces including:

- .1 Underground fuel tank liquid removal including testing of tank contents (liquid), removal and disposal of tank contents, and certification of contents and disposal.
- .2 Underground fuel tank cleaning and disposal including tank excavation, evacuation of combustible vapours, tank cleaning, disassembling of tank, and certification for proper disposal of tank.
- .3 Contamination assessment of site including soil testing, and where results indicate contamination removal and disposal of contaminated soil, and certification for proper disposal of contaminated soil; a change to contract will be considered where contaminated soil is found outside of area of excavation.

1.2 REFERENCE STANDARDS

.1 American Petroleum Institute (API):

- .1 API 1604-96, Closure of Underground Petroleum Storage Tanks.

.2 ASTM International (ASTM):

- .1 ASTM E1739-95 (2015), Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites.
- .2 ASTME1912-98 2004, Standard Guide for Accelerated Site Characterization for Confirmed or Suspected Petroleum Releases.
- .3 ASTM E1943-98 2015 Guide for Remediation of Ground water by Natural Attenuation at Petroleum Release Sites.

.3 Canadian Federal and Provincial Legislation and Guideline:

- .1 Canadian Environmental Protection Act (CEPA), 1999.
- .2 Canadian Environmental Assessment Act (CEAA), 1995.
- .3 Environment Canada Technical Assistance Bulletin TAB 8, Tanks.
- .4 Transportation of Dangerous Goods Act (TDGA), 1992.
- .5 Motor Vehicle Safety Act (MVSA), 1995.
- .6 Canadian Council of Ministers of the Environment (CCME).
- .7 PN1326, Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products.

.4 National Fire Protection Agency (NFPA):

- .1 NFPA 30: Flammable and Combustible Liquids Code (the most up-to-date).
- .2 NFPA 326: Standard for Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair (the most up-to-date).
- .3 NFPA 329: Recommended Practice for Handling Releases of Flammable and Combustible Liquids and Gases (the most up-to-date).

.5 Petroleum Tank Management Association of Alberta (PTMAA):

.1 Regulations for Underground Storage Tank Closures.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide required information in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit a written report describing in detail procedures used to remove liquid from underground storage tank, cleaning and removing of underground storage tank, and disposal of liquid residues; provide verification that materials were disposed of in an environmentally responsible waste disposal facility; provide photographic documentation of work, including lab and field results and receipts from disposal sites for tank and liquid residue.

.3 Submit a written contingency plan for actions to be taken in the event of a release or emergency including:

.1 Emergency contact numbers;

.2 Classification of land use;

.3 Plans for covering/containing contaminated soil;

.4 Plans for site assessment/remediation work; and

.5 Reducing risk to human health.

1.4 QUALITY ASSURANCE

.1 Refer to laws, by laws, ordinances, rules, regulations, and orders of Authority Having Jurisdictions, and other legally enforceable requirements applicable to Work at that area; or become in force during Work performance.

.2 Underground fuel tank removal and disposal shall comply with requirements of Authorities Having Jurisdiction.

Part 2 Products

2.1 MATERIALS

.1 Provide necessary materials, equipment, and tarps to prevent further contamination of site, and for safe handling and containment of fuel, fuel storage, and removed contaminated soils.

Part 3 Execution

3.1 PREPARATION

.1 Provide all necessary Personal Protective Equipment (PPE), purging and inert gases, and electrical protection equipment and verify that equipment is working properly before starting work of this Section.

3.2 UNDERGROUND STORAGE TANK REMOVAL

.1 Liquid Removal:

- .1 Provide samples of liquids from underground fuel storage tank to a certified hazardous waste testing facility for laboratory analysis and approval for liquid disposal and disposal location.
- .2 Remove liquid from tank for disposal prior to removing tank from ground.
- .3 Transfer oil to another storage tank at a facility designated by the owner, or properly dispose of the oil and obtain disposal facility receipts noting proper liquid disposal, at the owners option.

.2 Storage Tank Cleaning:

- .1 Remove tank from ground, place it on ground adjacent to removal location, and secure it prior to cleaning.
- .2 Measure levels of combustible vapours and oxygen, and ventilate tank if required to bring vapour or oxygen levels to safe limits:
  - .1 Ventilate tank using a small gas exhauster until vapour concentration is reduced to 10% or less of lower explosive limit.
  - .2 Oxygen content shall range from 19.5% to 23.5%.
  - .3 Cut access ports for cleaning into tank after vapour and oxygen concentrations are at a safe level.
- .3 Clean tank by mopping, scraping, sweeping, or steam cleaning interior of tank.
- .4 Collect, contain, and place residuals removed from tank in a 200 litre capacity drum for transporting and disposal acceptable to Authorities Having Jurisdiction.
- .5 Obtain disposal facility receipts noting proper effluent disposal.

.3 Storage Tank Disposal:

- .1 Verify that final vapour and oxygen concentrations are within requirements noted above before proceeding to cut and dismantle tank for its disposal.
- .2 Remove dismantled tank to a disposal facility acceptable to Authorities Having Jurisdiction.
- .3 Obtain disposal facility receipts noting proper tank disposal.

3.3 REMOVED TANK AREA ASSESSMENT

.1 Collect five soil samples from removed underground storage tank area as follows:

- .1 One sample from each of sidewalls.
- .2 One sample from base.

.2 Place samples in glass sample jars and seal with Teflon coated lids and place jar on ice.

.3 Deliver samples with completed chain of custody documentation to laboratory.

.4 Laboratory shall analyze each sample for Total Petroleum Hydrocarbon (TPH) concentrations.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 03 20 00 - Concrete Reinforcing.

.2 Section 03 30 00 - Cast-in-Place Concrete.

.3 Section 05 50 00 - Metal Fabrications

1.2 REFERENCE STANDARDS

.1 CSA Group (CSA):

.1 CSA A23.1:19/A23.2:19, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

.2 CSA O86:19, Engineering Design in Wood.

.3 CSA O121-17, Douglas Fir Plywood.

.4 CSA O151-17, Canadian Softwood Plywood.

.5 CSA O153-13, Poplar Plywood.

.6 CSA O325-16, Construction Sheathing.

.7 CSA O437.0-93, OSB and Waferboard.

.8 CSA S269.1-16, Falsework and Formwork.

.2 ULC Standards (ULC):

.1 CAN/ULC-S701.1:20, Standard for Thermal Insulation, Polystyrene Boards.

1.3 ADMINISTRATIVE REQUIREMENTS

.1 Coordinate with:

.1 Section 03 20 00 - Concrete Reinforcing.

.2 Section 03 30 00 - Cast-in-Place Concrete.

.3 Section 05 50 00 - Metal Fabrications, for items embedded or cast into concrete.

.2 Pre-Installation Meetings: Conduct a site meeting, attended by HRCE Representative and related Subcontractors to:

.1 Verify project requirements.

.2 Review delivery, storage, and handling requirements.

.3 Review installation and substrate conditions.

.4 Coordinate with other Subcontractors.

.5 Review manufacturer’s instructions and warranty requirements.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's instructions, product literature, and data sheets for proprietary materials used in formwork liners and coatings, including product characteristics, performance criteria, physical sizes, finishes, and limitations.

.2 Submit WHMIS Safety Data Sheet (SDS).

1.5 QUALITY ASSURANCE

.1 Retain a professional engineer registered or licensed in the Province of Nova Scotia, Canada with experience in formwork and falsework design of comparable complexity and scope to this Project to perform the following services as part of work of this section:

.1 Design of formwork and falsework.

.2 Review, stamp, and sign fabrication and erection shop drawings, design calculations and amendments.

.3 Conduct on-site inspections. Prepare and submit inspection reports verifying this part of work is in accordance with Contract Documents and reviewed Shop Drawings.

1.6 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment, and:

.1 Maintain formwork liners for architectural concrete without defects or damages that could affect concrete appearance or cause staining.

.2 Packaging Waste Management: Remove pallets, crates, padding, and packaging materials for reuse by manufacturer as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

.1 Formwork Materials:

.1 For concrete without special architectural features, use wood and wood product formwork materials to CSA O121 and CSA O86.

.2 Rigid insulation board: To CAN/ULC-S701.1.

.2 Tubular Column Forms: Sonotube Concrete Forms:

.1 Description: Multiple layers of 100 percent recycled paperboard, spirally wound, and laminated with adhesive.

.2 Interior Surface: Smooth with spiral seam. Alathon release and moisture barrier coating.

.3 Exterior Surface: Micryl moisture barrier coating.

.4 1-piece, 1-time-use forms.

.5 Recyclable.

.6 Inside Diameter: As indicated on the Drawings.

.3 Form Ties:

.1 For concrete not designated 'Architectural': Removable or snap-off metal ties, fixed or adjustable length, and free of devices leaving holes larger than 25 mm in diameter in concrete surface.

.4 Form Release Agent: Proprietary, non-volatile material that will not stain concrete or hinder the application of subsequent coatings, treatments, or flooring materials to the concrete surface.

.5 Falsework Materials: To CSA S269.1.

Part 3 Execution

3.1 PREPARATION

.1 Before placing concrete, clean formwork in accordance with CSA A23.1/A23.2.

3.2 FABRICATION AND ERECTION

.1 Verify lines, levels, and centres before proceeding with formwork/falsework. Confirm that dimensions match the Drawings.

.2 Fabricate and erect falsework in accordance with CSA S269.1.

.3 Do not place shores and mud sills on frozen ground.

.4 Provide site drainage to prevent washout of soil supporting mud sills and shores.

.5 Fabricate and erect formwork in accordance with CSA S269.1 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA A23.1/A23.2.

.6 Align form joints and make watertight:

.1 Minimize the number of form joints used.

.7 Use 25 mm chamfer strips on external corners and 25 mm fillets at interior corners and joints, unless otherwise indicated on Drawings.

.8 Form chases, slots, openings, drips, recesses, and expansion and control joints as indicated.

.9 Build in anchors, sleeves, and other inserts required to accommodate work specified in other sections:

.1 Ensure that anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including painting.

3.3 REMOVAL AND RESHORING

.1 Leave formwork in place after placing concrete for a minimum:

.1 7 days for walls, sides of beams, columns, footings, and abutments.

.2 Remove formwork when concrete has reached 70% of its 28-day design strength or minimum period noted above, whichever comes later, and replace immediately with adequate reshoring.

.3 Provide necessary reshoring of members where early removal of forms may be required or where members may be subjected to additional loads during construction as required.

.4 Space reshoring in each principal direction at not more than 3,000 mm apart.

.5 Reuse formwork and falsework subject to requirements of CSA A23.1/A23.2.

3.4 SITE QUALITY CONTROL

.1 Site Inspections:

.1 Professional engineer responsible for signing and stamping shop drawings to conduct on-site inspections and prepare and submit inspection reports verifying this part of the work is in accordance with Contract Documents and reviewed shop drawings.

.2 Perform inspections a minimum of one per month.

3.5 CLEANING

.1 Clean in accordance with Section 01 74 00 - Cleaning.

.2 Waste Management:

.1 Manage waste in accordance with Section 01 74 19 - Waste Management and Disposal, and:

.1 Once a form can no longer be used, deposit in an on-site recycling bin.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 03 30 00 - Cast-in-Place Concrete.

1.2 REFERENCE STANDARDS

.1 CSA Group (CSA):

.1 CSA A23.1:19/CSA A23.2:19, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

.2 CSA A283:19, Qualification Code for Concrete Testing Laboratories.

.3 CSA A23.3:19, Design of Concrete Structures.

.4 CSA G30.18-09, Carbon Steel Bars for Concrete Reinforcement.

.5 CSA G40.20-13/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

.6 CSA W186:21, Welding of Reinforcing Bars in Reinforced Concrete Construction.

.2 Reinforcing Steel Institute of Canada (RSIC):

.1 RSIC-2020, Manual of Standard Practice.

1.3 ADMINISTRATIVE REQUIREMENTS

.1 Coordination:

.1 Coordinate with Section 03 30 00 - Cast-in-Place Concrete.

.2 Pre-Installation Meetings: Hold pre-concrete pouring meeting one week before pouring concrete:

.1 Ensure HRCE Representative and other key personnel attend:

.1 Verify project requirements.

.2 Review reinforcing testing report.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer’s instructions if available, product literature and data sheets for proprietary materials used in concrete reinforcement. Include product characteristics, performance criteria, physical sizes, finishes, and limitations.

.2 Submit WHMIS Safety Data Sheet (SDS).

.3 Shop Drawings:

.1 Submit shop drawings stamped and signed by professional engineer registered or licensed in the Province of Nova Scotia, Canada.

.1 Prepare reinforcement drawings in accordance with RSIC Manual of Standard Practice.

.2 Indicate placing of reinforcement and:

.1 Bar bending details.

.2 Quantities of reinforcement.

.3 Detail lap lengths and bar development lengths to CSA A23.3, unless otherwise indicated on Drawings:

.1 Provide Type B tension lap splices unless otherwise indicated on Drawings.

.4 Indicate position and size of openings in slabs and walls. Coordinate with the different trades requiring openings.

.5 Indicate the concrete cover dimension to the reinforcement.

.4 Test and Evaluation Reports:

.1 When requested, submit certified copy of mill test report of reinforcing steel, showing physical and chemical analysis, minimum 4 weeks before beginning reinforcing work.

.5 Source Quality Control Submittals:

.1 When requested, submit, in writing, proposed source of reinforcement material.

1.5 QUALITY ASSURANCE

.1 Qualifications:

.1 Testing Laboratory: Certified to CSA A283.

1.6 DELIVERY, STORAGE, AND HANDLING

.1 Perform in accordance with Section 01 61 00 - Material & Equipment.

.2 Package bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists.

.3 Storage and Handling Requirements:

.1 Store materials off ground and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

Part 2 Products

2.1 MATERIALS

.1 Substitute different sized bars only if permitted in writing by HRCE Representative.

.2 Reinforcing Steel: Billet steel, grade 400, deformed bars to CSA G30.18, unless otherwise indicated.

.3 Cold-drawn annealed steel wire ties: To ASTM A1064/A1064M.

.4 Chairs, bolsters, bar supports, and spacers: To CSA A23.1/A23.2.

.5 Tie wire: 1.5 mm diameter annealed wire.

.6 Mechanical splices: Subject to approval from HRCE Representative.

.7 Plain round bars: To CSA G40.20/G40.21.

2.2 FABRICATION

.1 Fabricate reinforcing steel in accordance with CSA A23.1/A23.2 and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada.

.2 Obtain HRCE Representative's written approval for locations of reinforcement splices other than those shown on Contract Drawings and shop drawings.

Part 3 Execution

3.1 SITE BENDING

.1 Do not bend or weld reinforcement on site except where indicated or when authorized by HRCE Representative:

.1 If site bending is authorized, bend reinforcement without heat, applying slow and steady pressure.

.2 Replace reinforcement bars that develop cracks or splits.

3.2 PLACING REINFORCEMENT

.1 Place reinforcing steel as indicated on placing drawings in accordance with CSA A23.1/A23.2.

.2 Before placing concrete, obtain HRCE Representative's approval of reinforcing material and placement.

.3 Maintain minimum concrete cover to reinforcement during concrete placement.

3.3 SITE QUALITY CONTROL

.1 Site tests: When requested, Conduct tests on the following and submit report as described in ACTION AND INFORMATIONAL SUBMITTALS in Part 1 of this Section:

.1 Reinforcing steel and welded wire fabric.

.2 Inspection and testing of reinforcing and reinforcing materials carried out by testing laboratory for review to CSA A23.1/A23.2.

.3 Distribute test results for discussion at pre-pouring concrete meeting between testing laboratory and HRCE Representative.

.4 Contractor will pay for costs of tests.

.5 Inspection or testing by Owner does not augment or replace Contractor's quality control nor relieve Contractor of any contractual responsibility.

3.4 CLEANING

.1 Progress Cleaning: Clean in accordance with Section 01 74 00 - Cleaning.

.2 Final Cleaning: Upon completion remove surplus materials, rubbish, tools, and equipment in accordance with Section 01 74 00 - Cleaning.

.3 Waste Management: Perform in accordance with Section 01 74 19 - Waste Management and Disposal:

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

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 03 10 00 - Concrete Forming and Accessories.

.2 Section 03 20 00 - Concrete Reinforcing.

.3 Section 05 50 00 - Metal Fabrications

1.2 ABBREVIATIONS AND ACRONYMS

.1 Portland Cement: Hydraulic cement, blended hydraulic cement (XXb-b denotes blended), and Portland-limestone cement types:

.1 GU, GUb, GUL, and GULb: General use cement.

.2 MS, MSb, and MSLb: Moderate sulphate-resistant cement.

.3 MH, MHb, MHL, and MHLb: Moderate heat of hydration cement.

.4 HE, HEb, HEL, and HELb: High early-strength cement.

.5 LH, LHb, LHL, and LHLb: Low heat of hydration cement.

.6 HS, HSb, and HSLb: High sulphate-resistant cement.

1.3 REFERENCE STANDARDS

.1 ASTM International (ASTM):

.1 ASTM C171-20, Standard Specification for Sheet Materials for Curing Concrete.

.2 ASTM C260/C260M-10a, Standard Specification for Air-Entraining Admixtures for Concrete.

.3 ASTM C494/C494M-17, Standard Specification for Chemical Admixtures for Concrete.

.4 ASTM C881/C881M-20a, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

.5 ASTM C1017/C1017M-13e1, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.

.2 CSA Group (CSA):

.1 CSA A23.1:19 /A23.2:19, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

.2 CSA A3000-18, Cementitious Materials Compendium.

1.4 ADMINISTRATIVE REQUIREMENTS

.1 Coordination:

.1 Coordinate with Section 05 50 00 - Metal Fabrications for embedded bollards.

.2 Pre-Installation Meetings: Conduct a site meeting 1 week before beginning work of this Section attended by the HRCE Representative, site supervisor, and other related key personnel and Subcontractors to:

.1 Verify project requirements.

.2 Review delivery, storage, and handling requirements.

.3 Review installation and substrate conditions.

.4 Coordinate with other Subcontractors.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 When requested, submit the following action submittals minimum 4 weeks before starting work of this Section:

.1 Product data: Product literature and data sheets for proprietary materials used in cast-in-place concrete and additives, including product characteristics, performance criteria, physical sizes, finishes, WHMIS SDS, and limitations.

.2 Source quality control submittals:

.1 Valid and recognized certificate from the plant delivering the concrete.

.2 Test data and certification by qualified independent inspection and testing laboratory, confirming materials and mix designs used in concrete mixture meet specified requirements.

.3 Site quality control submittals:

.1 Proposed quality control procedures for:

.1 Falsework erection.

.2 Hot weather concrete.

.3 Cold weather concrete.

.4 Curing.

.5 Finishes.

.6 Formwork removal.

.7 Joints.

.2 Quality control plan: Submit written report to the HRCE Representative verifying compliance that cast-in-place concrete meets performance requirements of concrete as established in PRODUCTS in this Section.

.3 Submit the following informational submittals as work progresses:

.1 Site quality control submittals:

.1 Testing and Inspection results and reports: Do not proceed without written acceptance when deviations from mix design or parameters are found.

.2 Concrete pours: Submit accurate records of poured concrete items indicating date and location of pour, quality, air temperature, and test samples taken as described in SITE QUALITY CONTROL in this Section.

.3 Concrete hauling time: Submit records of deviations exceeding the maximum allowable time of 120 minutes for concrete delivered to site of Work and discharged after batching.

1.6 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment, and:

.1 Delivery and Acceptance Requirements:

.1 Concrete hauling time: Deliver to site of Work and discharge within 120 minutes after batching.

.2 Modifying maximum time limit before receiving written acceptance from the HRCE Representative and concrete producer, as described in CSA A23.1/CSA A23.2, is prohibited.

.3 Submit deviations for review by the HRCE Representative.

.4 Concrete delivery: Ensure continuous concrete delivery from plant meets CSA A23.1/CSA A23.2.

1.7 SITE CONDITIONS

.1 Placing concrete during rain or weather events that could damage concrete is prohibited.

.2 Protect newly placed concrete from rain or weather events in accordance with CSA A23.1/CSA A23.2.

.3 Cold Weather Protection:

.1 Maintain protection equipment in readiness on site.

.2 Use protection equipment when ambient temperature is below 5 °C, or when temperature may fall below 5 °C before concrete has cured.

.3 Placing concrete upon or against surface at temperature below 5 °C is prohibited.

.4 Hot Weather Protection:

.1 Protect concrete from direct sunlight when ambient temperature is above 27 °C.

.2 Prevent forms from getting too hot before concrete is placed. Apply accepted methods of cooling that will not negatively affect concrete.

.5 Protect concrete from drying.

Part 2 Products

2.1 DESIGN CRITERIA

.1 Alternative 1-Performance: To CSA A23.1/CSA A23.2, and as described in MIXES in this Section.

2.2 PERFORMANCE CRITERIA

.1 Quality Control Plan: Ensure concrete supplier meets performance criteria of concrete as established by the HRCE Representative and submit verification of compliance as described in ACTION AND INFORMATIONAL SUBMITTALS in this Section.

2.3 MATERIALS

.1 Portland Cement: GU.

.2 Blended Hydraulic Cement: Type GUb to CSA A3000 (specifically CSA A3001).

.3 Water: To CSA A23.1/CSA A23.2.

.4 Aggregates: To CSA A23.1/CSA A23.2.

.5 Admixtures:

.1 Air entraining admixture: To ASTM C260/C260M.

.2 Chemical admixture: To ASTM C494/C494M. The HRCE Representative to review accelerating or set retarding admixtures during cold and hot weather placing.

2.4 MIXES

.1 Alternative 1-Performance Method for Specifying Concrete: To meet HRCE Representatives performance criteria to CSA A23.1/CSA A23.2:

.1 Concrete supplier to meet performance criteria as established below and verify compliance in accordance with the quality control plan.

.2 Provide exterior concrete mix to meet specified hard state requirements:

.1 Durability and class of exposure: C-1.

.2 Compressive strength at 56 days age: Minimum 35 MPa.

.3 Intended application: Exterior Foundations.

.4 Coarse aggregate size maximum 20 mm.

.3 Provide interior concrete mix to meet specified hard state requirements:

.1 Durability and class of exposure: N.

.2 Compressive strength at 28 days age: Minimum 25 MPa.

.3 Intended application: Interior Housekeeping Pads.

.4 Coarse aggregate size maximum 20 mm.

Part 3 Execution

3.1 PREPARATION

.1 Obtain HRCE Representative's written acceptance before placing concrete:

.1 Provide a minimum of 24 hours notice before placing of concrete.

.2 Place concrete reinforcing in accordance with Section 03 20 00 - Concrete Reinforcing.

.3 During concreting operations:

.1 Prevent development of cold joints.

.2 Verify concrete delivery and handling facilitate placing with minimum amount of re-handling and without damage to existing structure or Work.

.4 Pumping of concrete permitted only after acceptance of equipment and mix.

.5 Disturbing reinforcement and inserts during concrete placement is prohibited.

.6 Before placing of concrete, obtain HRCE Representatives acceptance of proposed method for protection of concrete during placing and curing in adverse weather.

.7 Protect previous work from staining.

.8 Clean and remove stains before applying concrete finishes.

.9 Maintain accurate records of poured concrete items. Indicate date, location of pour, quality, workability, air content, temperature, and test samples taken.

3.2 INSTALLATION/APPLICATION

.1 Perform cast-in-place concrete work in accordance with CSA A23.1/CSA A23.2.

.2 Anchor Bolt Installation:

.1 Set anchor bolts to templates in coordination with appropriate Subcontractor before placing concrete.

.2 Grout anchor bolts in preformed holes or holes drilled after concrete has set only after receipt of written acceptance from the HRCE Representative:

.1 Drilled holes: To manufacturers recommendations.

.3 Protect anchor bolt holes from water accumulation, and snow and ice build-ups.

.4 Set bolts and fill holes with epoxy grout.

.3 Finishing and Curing:

.1 Finish concrete to CSA A23.1/CSA A23.2.

.2 Use procedures reviewed by the HRCE Representative to remove excess bleed water. Ensure surface is not damaged.

.3 Cure concrete in accordance with CSA A23.1/CSA A23.2.

.4 Provide screed finish unless indicated otherwise.

.5 Rub exposed sharp edges of concrete with carborundum to produce a minimum 3 mm radius edges unless otherwise indicated.

3.3 TOLERANCES

.1 Concrete Surface Tolerance: To CSA A23.1/CSA A23.2 to Tolerance indicated on Drawings.

3.4 SITE QUALITY CONTROL

.1 Site Tests: Conduct tests and submit report as described in ACTION AND INFORMATIONAL SUBMITTALS in this Section:

.1 Concrete pours.

.2 Slump.

.3 Air content.

.4 Compressive strength.

.5 Air and concrete temperature.

.2 Inspection and testing of concrete and concrete materials carried out by testing laboratory designated by the HRCE Representative in accordance with CSA A23.1/CSA A23.2:

.1 Distribute test results for discussion at pre-pouring concrete meeting between the testing laboratory and HRCE Representative.

.3 Payment for Testing Laboratory Services: By Contractor.

.4 The Testing agency will take additional test cylinders during cold weather concreting. Cure cylinders on Project site under same conditions as concrete which they represent.

.5 Non-Destructive Methods for Testing Concrete: To CSA A23.1/CSA A23.2.

.6 Inspection or testing by the Consultant does not augment or replace Contractor's quality control or relieve the Contractor of contractual responsibility.

3.5 CLEANING

.1 Clean in accordance with Section 01 74 00 - Cleaning, and:

.1 Provide appropriate area on Project site where concrete trucks can be safely washed.

.2 Manage waste in accordance with Section 01 74 19 - Waste Management and Disposal, and:

.1 Divert unused concrete materials from landfill to local facility.

.2 Divert unused admixtures and additive materials (pigments, fibres, etc.) from landfill to official hazardous material collections site.

.3 Prevent disposal of unused admixtures and additive materials, concrete, concrete washwater, or cleaning materials and residues into sewer systems, lakes, streams, onto ground, or in other locations that pose a health or environmental hazard.

.4 Prevent admixtures and additive materials from entering drinking water supplies or streams.

.5 Collect liquid or solidify liquid with inert, non-combustible material, and remove for disposal.

3.6 PROTECTION

.1 Do not place load upon new concrete until authorized by the HRCE Representative.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 05 50 00 - Metal Fabrications.

1.2 REFERENCE STANDARDS

.1 CSA Group (CSA):

.1 CSA A165 Series-14, CSA Standards on Concrete Masonry Units (Consists of A165.1 Concrete Block Masonry Units, A165.2 Concrete Brick Masonry Units, and A165.3 Prefaced Concrete Masonry Units).

.2 CAN/CSA-A179-14, Mortar and Grout for Unit Masonry.

.3 CAN/CSA-A370:14, Connectors for Masonry.

.4 CAN/CSA A371-14, Masonry Construction for Buildings.

.5 CSA G30.18-09, Carbon Steel Bars for Concrete Reinforcement.

.6 CSA S304-14, Design of Masonry Structures.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS):

.1 Safety Data Sheets (SDS)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's instructions, product literature, and data sheets for unit masonry products, mortar and grout, connectors, anchorage and reinforcing, and accessories. Include product characteristics, performance criteria, physical size, finish, and limitations.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Perform in accordance with Section 01 61 00 - Material & Equipment.

.2 Delivery and Acceptance Requirements: Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean and well-ventilated area.

.2 Store and protect masonry products from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new ones.

1.5 COLD WEATHER REQUIREMENTS

.1 Supplement requirements of CAN/CSA-A371 as follows:

.1 Maintain temperature of mortar between -5 °C and 50 °C until used.

1.6 HOT WEATHER REQUIREMENTS

.1 Supplement requirements of CAN/CSA-A371 as follows:

.1 Protect freshly laid masonry from drying too rapidly by using waterproof, non-staining coverings.

Part 2 Products

2.1 MASONRY UNITS

.1 Standard concrete block units: To CSA A165 (specifically CSA A165.1):

.1 Classification: H / 15 / A / M.

.2 Size: Modular.

.3 Dimensions: 203 mm wide x 406 mm long x 203 mm high.

.4 Texture(s)/Profile(s): Ribbed.

2.2 MORTAR AND GROUT

.1 Mortar: To CAN/CSA-A179:

.1 Use aggregate passing 1.18 mm sieve where 6 mm thick joints are indicated.

.2 Mortar Type:

.1 Interior non-loadbearing walls: Type N based on proportion specifications.

.3 Grout: To CAN/CSA-A179, Table 3.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: Verify that conditions of substrates previously installed under other Sections or Contracts are acceptable for product installation in accordance with manufacturer's written instructions:

.1 Visually inspect substrate in presence of HRCE Representative.

.2 Inform HRCE Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from HRCE Representative.

3.2 INSTALLATION

.1 Do masonry work in accordance with CAN/CSA-A371 except where specified otherwise:

.1 Bond: Running stretcher bond with vertical joints in perpendicular alignment and centered on adjacent stretchers above and below.

.2 Coursing height: 200 mm for one block and one joint.

.3 Jointing: Tool where exposed or where paint or other finish coating is specified to provide smooth, compressed, concave surface.

.2 Build masonry plumb, level, and true to line, with vertical joints in alignment.

.3 Layout coursing and bond to achieve correct coursing heights, and continuity of bond above and below openings with a minimum amount of cutting.

3.3 CONSTRUCTION

.1 Exposed masonry:

.1 Remove chipped, cracked, and otherwise damaged units in exposed masonry and replace with undamaged units.

.2 Cut out for electrical switches, outlet boxes, and other recessed or built-in objects. Make cuts straight, clean, and free from uneven edges.

.2 Building-in:

.1 Install masonry connectors and reinforcement where indicated on drawings.

.2 Build-in items required to be built into masonry.

.3 Prevent displacement of built-in items during construction. Check plumb, location, and alignment frequently, as work progresses.

.3 Interface with other work:

.1 Cut openings in existing work as indicated.

.2 Openings in walls: Approved by HRCE Representative.

.3 Make good existing work. Use materials to match existing.

3.4 MODIFICATIONS TO EXISTING MASONRY

.1 Match existing bond and coursing height of adjacent masonry to remain.

.2 Tooth new masonry into existing masonry in run of wall and at intersections with existing partitions.

.3 At new openings in masonry walls, remove units, clean and re-install rotated to conceal cut and expose finish surface.

.4 Clean bond areas of adjacent masonry to remain, remove loose material and prepare masonry to receive new masonry toothed in.

.5 Install reinforcement as necessary to provide continuity of reinforcing and stability between existing and new masonry work.

.6 Provide repair anchors as necessary to stabilize existing masonry adjacent to and affected by the Work.

3.5 GROUTING

.1 Grout masonry in accordance with CAN/CSA-A179, CAN/CSA-A371 and as indicated.

3.6 SITE TOLERANCES

.1 Tolerances of CAN/CSA-A371 apply.

3.7 CLEANING

.1 Progress Cleaning: Perform 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:

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

.2 Return pallets to masonry manufacturer for re-use.

.3 Return surplus masonry materials to manufacturer for recycling or re-use.

3.8 PROTECTION

.1 Protect masonry and other work from marking and other damage. Protect completed work from mortar droppings. Use non-staining coverings.

.2 Repair damage to adjacent materials caused by masonry products installation.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section includes:

.1 Bollards.

.2 Mechanical equipment frames.

.3 Miscellaneous metal fabrications.

1.2 REFERENCE STANDARDS

.1 ASTM International (ASTM):

.1 ASTM A307-21, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.

.2 ASTM F3125-15, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1,040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.

.2 CSA Group (CSA):

.1 CSA G40.20/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

.2 CSA G164-18, Hot Dip Galvanizing of Irregularly Shaped Articles

.3 CSA S16:19, Design of Steel Structures.

.4 CSA W48:23, Filler Metals and Allied Materials for Metal Arc Welding.

.5 CSA W59-18, Welded Steel Construction (Metal Arc Welding).

.3 The Master Painters Institute (MPI):

.1 Architectural Painting Specification Manual (ASM), Current Edition.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit the following action submittals before starting work of this section:

.1 Product Data: Product literature and data sheets for installed products, including product characteristics, performance criteria, physical sizes, finishes, and limitations:

.1 WHMIS SDS for site-applied primers, coatings, paints, and other finishes.

.2 Shop Drawings:

.1 Sealed and signed by a qualified professional in accordance with Section 01 45 00 - Quality Control.

.2 Indicate materials, base metal thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.

.2 Certificates:

.1 Qualification Statements for Application Specialists: In accordance with ANSI/NACE No. 13/SSPC-ASC-1.

Part 2 Products

2.1 MATERIALS

.1 Steel Tubes: To CSA G40.20/G40.21, Grade 350W.

.2 Welding Materials: To CSA W59.

.3 Welding Electrodes: To CSA W48 Series.

.4 Bolts: To ASTM F3125, Grade A325.

.5 Anchor Bolts: To ASTM F1554, Grade 36:

.1 Anchors into existing masonry wall to include epoxy adhesive and inserts as indicated on drawings.

.6 Grout: Non-shrink, non-metallic, flowable, 15 MPa at 24 hours.

2.2 FABRICATION

.1 Fabricate work square, true, straight, and accurate to required size, with joints closely fitted and properly secured.

.2 Use self-tapping, shake-proof flat-headed screws on items requiring assembly by screws or as indicated.

.3 Where possible, fit and shop-assemble work, ready for erection.

.4 Make exposed welds continuous for length of each joint. File or grind exposed welds smooth and flush.

2.3 BOLLARD FABRICATION

.1 Fabricate bollards to sizes indicated from CSA G40.20/G40.21, Grade 350W steel tubes:

.1 Length: As indicated on drawings.

.2 Galvanize bollards.

2.4 MISCELLANEOUS FABRICATIONS

.1 Miscellaneous Framing and Supports: Provide steel framing and supports for applications indicated that are not part of structural steel framework, as required to complete the Work.

.2 Fabricate units to sizes, shapes, and profiles indicated and required to receive adjacent construction retained by framing and supports. Fabricate from structural steel shapes, plates, and steel bars of welded construction using mitred joints for site connection. Cut, drill, and tap units to receive hardware, hangers, and similar items.

2.5 FINISHES

.1 Primer Materials:

.1 Shop coat primer: To MPI ASM INT 5.1.

.2 Shop Finishing Methods:

.1 Galvanizing: To CSA G164, hot-dip galvanizing with 600 g/m^2 zinc coating.

.2 Shop painting: In accordance with MPI ASM:

.1 Apply one shop coat of primer to metal items, with the exception of galvanized or concrete encased items.

.2 Use unadulterated primer as prepared by manufacturer. Paint on dry surfaces, free from rust, scale, and grease when temperature is a minimum 7 °C.

.3 Clean surfaces to be site welded; do not paint.

.4 Leave surfaces to be welded and surfaces receiving sprayed fireproofing unpainted and unprimed.

.5 Leave surfaces to be embedded in concrete unpainted.

.6 Apply two coats of primer to parts inaccessible after final assembly.

Part 3 Execution

3.1 PREPARATION

.1 Thoroughly clean and suitably pre-treat steel prior to finishing.

.2 Remove loose mill scale, rust, oil, grease, dirt, and other foreign matter using one or more of the following methods:

.1 Solvent cleaning.

.2 Wire brushing.

.3 Power wire brushing.

.4 Abrasive blasting.

.3 Grind sharp projections until smooth.

.4 Prepare metal surfaces to receive paint finishes in accordance with MPI ASM.

3.2 INSTALLATION - GENERAL

.1 Install metal fabrications as indicated on Drawings.

.2 Install in accordance with reviewed shop drawings, square, plumb, straight, true, accurately fitted, and with tight joints and intersections.

.3 Perform welding in accordance with CSA W59 unless specified otherwise.

.4 Provide exposed fastening devices to match finish and be compatible with material through which they pass.

.5 Make site connections with fasteners to CSA S16.

.6 Touch up rivets, site welds, bolts, and burnt or scratched surfaces with primer after installation:

.1 Primer: In accordance with 2.5 FINISHES in this section.

3.3 BOLLARD INSTALLATION

.1 Install bollards as indicated on Drawings.

.2 Fill with concrete in accordance with Section 03 30 00 - Cast-in-Place Concrete. Form smooth, rounded top.

.3 Paint bollards on site.

.1 Colour: Safety yellow.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 This Section specifies fire stop and smoke seal systems and materials intended to fill gaps between fire separations, between fire separations and other construction assemblies, or used in or around items which fully or partially penetrate a fire separation, to restrict the spread of fire and smoke thus maintaining the integrity of a fire separation.

.2 This Section includes requirements for:

.1 Through-penetration fire stops:

.1 For openings created to allow a penetrating item such as piping, conduits, raceways, ducts, cable trays, cables, tubing, or structural components to pass completely through a fire separation or fire-resistance rated assembly.

.2 Membrane penetration fire stops:

.1 For openings where penetrating items such as piping, conduits, raceways, ducts, cable trays, cables, tubing, recessed components (e.g. panels, electric boxes, devices), or structural components pass through only one membrane of a fire separation or fire-resistance rated assembly.

.3 Blank opening fire stops:

.1 For openings created in a fire separation where the penetrating item has not yet been installed or has been removed.

.3 This Section includes fire stopping and smoke seal work for the entire Project including selection, installation, and inspection of all required fire stops.

1.2 DEFINITIONS

.1 Fire Blocking: materials, components, or system installed in a concealed space in the building to restrict the spread of fire and smoke in that concealed space or from that concealed space to an adjacent space.

.2 Fire Compartment: spaces within a building that are enclosed by exterior walls or separated from other parts of the building by enclosing Fire Separations having a Fire-Resistance Rating.

.3 Fire-Resistance Rating: time in minutes or hours that a material or assembly of materials will withstand the passage of flame and transmission of heat when exposed to fire, meeting the requirements of CAN/ULC-S101 or as determined by formal testing of material or assembly of materials, meeting requirements of CAN/ULC-S115, or an interpretation of information derived from formal testing in accordance with requirements of the Building Code and acceptable to the Authority Having Jurisdiction (AHJ).

.4 Fire Separation: assembly that acts as a barrier against the spread of fire, smoke and noxious gases resulting from combustion as defined by the Building Code and includes the following assemblies having a Fire-Resistance Rating requiring Fire Stopping as follows:

.1 Penetration-Type Fire Stop systems located within loadbearing walls and partitions.

.2 Penetration-Type Fire Stop systems located within non-loadbearing walls and partitions.

.3 Penetration-Type located within floor assemblies.

.5 Fire Stop: material, component, or system and its means of support, used to protect gaps between fire separations, between fire separations and other construction assemblies, or used in openings where penetrating items wholly or partially penetrate fire separations, to restrict the spread of fire and smoke thus maintaining the fire-resistance continuity of a fire separation.

.6 Fire Stop System: a specific site erected construction consisting of the assembly, fire stop materials, any penetrating items, and their means of support which have met the requirements for an F, FT, FH, FTH, and/or L rating when tested in a fire-resistance rated assembly in accordance with CAN/ULC-S115:

.1 F-Rating: the amount of time a fire stop system can remain in place without the passage of flame through the opening or the occurrence of flaming on the unexposed face of the fire stop.

.2 FT-Rating: a fire stop system with an F-Rating for the required time period which can also resists the transmission of heat through the fire stop during the same period and limit the rise in temperature on the unexposed face and/or penetrating item of the fire stop.

.3 FH-Rating: a fire stop system with an F-Rating for the required time period which can also resist the force of a hose stream without developing openings for a prescribed period.

.4 FTH-Rating: a fire stop system with an FT-Rating for the required time period which also passes the hose stream test for a prescribed period.

.5 L-Rating: largest test sample leakage rate, determined in accordance with the optional air leakage test in CAN/ULC-S115.

.7 Multi-penetration: two or more service penetrations through an opening in the fire separation.

.8 Non-rated Fire Separation: fire separation acting as a barrier to the spread of smoke until a response is initiated such as the activation of a fire suppression system.

.9 Single-penetration: single service penetration through an opening in the fire separation.

.10 System Design Listing: document providing proof of testing with technical details, specifications and requirements that leads to the application of a specific listed fire stop system.

1.3 REFERENCE STANDARDS

.1 ASTM International (ASTM):

.1 ASTM A1008/A1008M-13 Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable.

.2 ASTM C719-14, Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle).

.3 ASTM C920-14, Standard Specification for Elastomeric Joint Sealants.

.4 ASTM E84-21, Standard Test Method for Surface Burning Characteristics of Building Materials.

.5 ASTM E119-20, Standard Test Methods for Fire Tests of Building Construction and Materials.

.6 ASTM E136-19A, Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 degrees.

.7 ASTM E595-15, Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment.

.8 ASTM E814-13a, Standard Test Method for Fire Tests of Penetration Firestop Systems.

.9 ASTM E1966 15, Standard Test Method for Fire Resistive Joint Systems.

.10 ASTM E2032-09, Standard Guide for Extension of Data From Fire Resistance Tests Conducted in Accordance with ASTM E 119.

.11 ASTM E2174-20A, Standard Practice for On-Site Inspection of Installed Firestops.

.12 ASTM E2393-20A, Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers.

.2 Firestop Contractors International Association (FCIA):

.1 FCIA Firestop Manual of Practice, 6th Edition 2015.

.3 Factory Mutual Approvals (FM):

.1 FM 4990-2009, Approval Standard for Firestopping.

.2 FM 4991-2013, Approval Standard for Firestop Contractors.

.4 International Accreditation Service (IAS):

.1 IAS AC291-19, Accreditation Criteria for Special Inspection Agencies.

.5 International Firestop Council (IFC)

.1 IFC Guidelines for Evaluating Engineering Judgments.

.2 IFC Guidelines for Evaluating Engineering Judgments-Perimeter Fire Barrier Systems.

.3 IFC Inspection Guidelines for Penetration Firestop Systems and Fire Resistive Joint Systems in Fire Resistance Rated Construction, 5th Edition.

.6 National Fire Protection Agency (NFPA):

.1 NFPA 251-2006, Standard Methods of Tests of Fire Endurance of Building Construction and Materials.

.7 National Research Council Canada (NRC):

.1 National Building Code of Canada (NBC) 2020.

.2 Best Practice Guide on Fire Stops and Fire Blocks and Their Impact on Sound Transmission 2007.

.8 ULC Standards (ULC):

.1 CAN/ULC-S101-14, Standard Method of Fire Endurance Tests of Building Construction and Materials.

.2 CAN/ULC-S102-10, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

.3 CAN/ULC-S114-05, Standard Method of Test for Determination of Non-Combustibility in Building Materials.

.4 CAN/ULC-S115-11, Standard Method of Fire Tests of Firestop Systems.

.9 Underwriters Laboratories Inc. (UL):

.1 UL 1479-2015, Fire Tests of Penetration Firestops.

.2 UL Qualified Firestop Contractor Program.

1.4 ADMINISTRATIVE REQUIREMENTS

.1 Sequencing:

.1 Proceed with installation only when submittals have been reviewed by the HRCE Representative.

.2 Install fire stops located in floor assemblies before interior partition erections.

.3 Metal deck bonding: Unless otherwise noted on system design listing and manufacturer's installation instructions, fire stopping to precede spray-applied fireproofing to ensure required bonding.

.4 Pipe and duct insulation: Certified fire stop system component:

.1 Ensure pipe and duct insulation installation precedes fire stopping.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Qualification Statement:

.1 Submit contractor qualification statements and certificates demonstrating compliance with the qualification requirements of this Section, as described in PART 1 - QUALITY ASSURANCE, within Ten working days after award of contract and before starting Work.

.3 Product Data:

.1 Submit manufacturer's product data for each type of fire stopping and smoke seal. Submit complete product data for each individual component and include:

.1 Product name and product number.

.2 Product characteristics and performance criteria.

.3 Physical size, finish and limitations.

.4 Technical data on out-gassing, off-gassing, and age testing.

.5 Curing time.

.6 Chemical compatibility to other construction materials.

.7 Shelf life.

.8 Life expectancy.

.9 Temperature range for installation.

.10 Humidity range for installation.

.11 Sound attenuation STC-Rating.

.2 Manufacture Product Certification:

.1 Submit manufacturer certification certifying products supplied comply with local regulations controlling use of Volatile Organic Compounds (VOCs) and are non-toxic to building occupants.

.2 Submit test reports showing compliance to ASTM E595.

.3 Submit one copy of WHMIS Safety Data Sheets (SDS) for each individual component.

.4 Submit a comprehensive list of all products and components included in submittal.

.4 Shop Drawings:

.1 Submit shop drawings showing system design listings for Project including proposed materials, reinforcement, anchorage, fastenings, and method of installation.

.2 Construction details to accurately reflect actual job conditions for each product and assembly.

.3 Submit details for materials and prefabricated devices.

.4 Submit an electronic copy of shop drawings and include:

.1 Title page, labelled "Fire and Smoke Stop System Listings". Include project name, date and the names of the installation company and the manufacturer of proposed products. Insert title in front and spine of binder.

.2 Table of Contents at front of each binder.

.3 List of each proposed listed fire stop system and corresponding service penetration type or joint type in a matrix spreadsheet schedule, indicating floor and wall system, including rating for each.

.4 System Design Listings:

.1 Submit design listings for each listed fire stop system and each application identified in accordance with CAN/ULC-S115.

.2 When more than one product is specified for the listed fire stop system or more than one packing/damming material is indicated, identify the item that will be used on this Project.

.5 Certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Manufacturer's Instructions: Submit manufacturer's installation instructions and special handling criteria, installation sequence, and cleaning procedures.

.6 Quality Assurance Submittals: Submit the following in accordance with Section 01 45 00 - Quality Control:

.1 Test reports in accordance with CAN/ULC-S101, CAN/ULC-S102, and CAN/ULC-S115:

.1 Submit certified test reports from approved independent testing laboratories, indicating compliance of applied fire stopping with specifications for specified performance characteristics and physical properties.

.2 Certificates: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.3 Manufacturer's Instructions: Submit manufacturer's installation instructions and special handling criteria, installation sequence, and cleaning procedures.

.7 Engineering Judgments (EJ):

.1 Where there is no specific tested listed fire stop system available from the manufacturer for a particular fire stop configuration, review systems from other manufacturers to obtain a listed fire stop system.

.2 Submit an EJ from the system manufacturer if there are no listed systems available from other manufacturers.

.3 Prepare and submit an EJ in accordance with best practices established in the following documents:

.1 IFC Guidelines for Evaluating Engineering Judgments.

.2 IFC Guidelines for Evaluating Engineering Judgments-Perimeter Fire Barrier Systems.

.4 For each EJ submitted, include:

.1 Project name, number, and location.

.2 A description of the proposed system with detailed drawing.

.3 Installation instructions.

.4 Complete descriptions of critical elements for the fire stop configuration.

.5 Copies of all referenced system design listings which EJ is based on.

.6 EJ issuer name and contact information.

.7 Date of issue of EJ with authorization signature of issuer.

.5 EJ shall only be issued by fire stop manufacturer's qualified technical personnel or in collaboration with the manufacturer by a knowledgeable registered Professional Engineer, a Fire Protection Engineer, or an independent testing agency that provides testing and listing services for fire stop systems similar to the EJ being contemplated.

.6 EJ shall be based upon interpolations of previously tested fire stop systems that are either sufficiently similar in nature or clearly bracket the conditions upon which the EJ is to be given. Additional knowledge and technical interpretations based upon accepted engineering principles, fire science, and fire testing guidelines (e.g. ASTM E2032) may also be used as further support data.

.7 EJ shall be based upon knowledge of the elements of the construction to be protected and understanding of the probable behaviour of that construction and the recommended fire stop system protecting it were they to be subjected to the adequate standard fire test method for the required fire rating duration.

.8 EJ shall be limited to the specific conditions and configurations for which it was created and should be based upon reasonable performance expectations for the recommended fire stop system under those conditions.

.9 EJ shall be accepted only for a single specific job and location and should not be transferred to any other job or location without thorough and appropriate review of all aspects of the next job or location's circumstances:

.1 Manufacturer letter stating their opinion, with supporting justification, that the EJ will perform as a fire stop system when subjected to the appropriate standard fire test method for the required fire rating duration.

.10 Once the EJ has been reviewed, submit to the AHJ for final approval.

.8 Closeout Submittals:

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

.9 Operation and Maintenance Data: Submit maintenance data for incorporation into manual, including:

.1 WHMIS Safety Data Sheets (SDS);

.2 Product data and manufacturer's installation and maintenance instructions for each product/system used on this project;

.3 Approved system design listings and EJs;

.4 Certifications;

.5 Warranty information on fire stop installations; and

.6 Life expectancy of each product installed as part of Project. For each system, list the installation date of products and the expected expiration date (month/year).

1.6 QUALITY ASSURANCE

.1 Regulatory Requirements: Use materials and methods of determining required thickness of application that have the full acceptance of AHJ and that are tested in accordance with CAN/ULC-S115, and form a part of a ULC or cUL listed system, Engineered Judgement or Equivalent Fire Resistance Rated Assembly.

.2 Provide systems selection and analysis, installation and inspection of fire stop systems in accordance with the recommended practices detailed in the following guides:

.1 FCIA Firestop Manual of Practice (MOP).

.3 Qualifications:

.1 Contractor specializing in selection and installation of fire stops approved by manufacturer. Submit a list of five successfully completed projects of similar scale and type.

.2 The installers are recognized as a Member in Good Standing with the Firestop Contractors International Association (FCIA). Submit proof of current membership.

.3 Training: Workers, including site supervisor, to complete:

.1 Manufacturer training on the products/systems installed as part of this Section.

.2 Training under the FCIA Firestop Containment Worker Education Program.

.4 Certified Firestop Contractor: company certified with one of the following programs:

.1 ULC Qualified Firestop Contractor Program. Submit signed copy of certificate.

.2 FM 4991 Approved Firestop Contractor. Submit signed copy of FM Approval certificate.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling, and unloading:

.1 Perform in accordance with Section 01 61 00 - Material & Equipment.

.2 Deliver materials to the site in undamaged condition and in original unopened containers, marked to indicate brand name, manufacturer, ULC markings, manufacturing date, and shelf life expiry date.

.2 Storage and Protection:

.1 Store materials in a well-ventilated, dry indoor location, and in accordance with manufacturer's instructions.

.2 Coordinate delivery of materials with scheduled installation dates to allow minimum storage time on site.

.3 Comply with recommended procedures, precautions and measures described in WHMIS Safety Data Sheets (SDS).

.3 Waste Management and Disposal:

.1 Perform in accordance with Section 01 74 19 - Waste Management and Disposal.

1.8 AMBIENT CONDITIONS

.1 Ambient Conditions:

.1 Install fire stops and smoke seals when ambient and substrate temperatures are within the limits prescribed by the manufacturer and when the substrate is dry and without risk of condensation.

.2 Maintain manufacturer's recommended ambient and substrate temperatures for 48 hours before and 72 hours after installation.

.2 Ventilate fire stops and smoke seals in accordance with manufacturers' instructions by natural means or, where this is inadequate or not available, use forced air circulation.

1.9 WARRANTY

.1 Extend 12 month warranty period to 24 months for Work of this Section.

.2 Manufacturers shall warrant work of this Section against defects and deficiencies in the product material for a period of 24 months. Promptly correct any defects or deficiencies which become apparent within warranty period at no expense.

.3 Contractor warrants workmanship on materials and installation for a period of 24 months. Promptly correct any defects or deficiencies which become apparent within warranty period at no expense.

Part 2 Products

2.1 MANUFACTURERS

.1 Provide products from a single manufacturer, to the greatest extent possible, to perform all fire stopping work. Materials of different manufacturers will not be permitted without authorization from the HRCE Representative.

.2 Provide a listed system from an alternative where there is no specific tested listed fire stop system available from the manufacturer for a particular fire stopping application to avoid providing an Engineering Judgment.

2.2 PERFORMANCE/DESIGN CRITERIA

.1 Fire stop and smoke seal systems consisting of a material or combination of materials installed to maintain the integrity of the fire-resistance rating of a fire separation in accordance with the requirements of the NBC.

.2 Performance Requirements: Manufacturer shall design proprietary assemblies to withstand the listed ratings in accordance with the NBC, ULC Standards, and AHJ, and as follows:

.1 Non-rated fire separations: Provide L-Rated smoke protection fire stop system for application on both sides of separation.

.2 Provide through-penetration fire stop and joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of penetrated assembly, such as:

.1 Fire-resistance rated loadbearing walls, including partitions, with fire protection rated openings.

.2 Fire-resistance rated non-loadbearing walls, including partitions with fire protection rated openings.

.3 Fire-resistance rated floor assemblies.

.3 “F” Rated Systems: Provide through-penetration fire stop systems with F-ratings indicated, as determined by CAN/ULC-S115 or ASTM E814, and equal to or exceeding the fire-resistance rating of the penetrations created during construction.

.4 “T” Rated Systems: Where fire stop systems protect penetrating items from potential contact with adjacent materials, provide through-penetration fire stop systems with T-ratings and F-ratings indicated, as determined by CAN/ULC-S115 or ASTM E814, for the following conditions:

.1 Penetrations located outside wall cavities.

.2 Penetrations located outside fire resistive shaft enclosures.

.3 Penetrations located in a construction containing fire protection rated openings.

.4 Penetrating items larger than a 100 mm-diameter nominal pipe or 100 cm^2 in overall cross-sectional area.

.5 Fire stopping and Smoke Seal Systems Exposed to View: Provide products that after curing do not deteriorate when exposed to view, traffic, moisture, and physical damage both during and after construction, and as follows:

.1 Provide moisture resistant through-penetration fire stop systems for piping penetrations for plumbing and wet pipe sprinkler systems.

.2 Provide fire stopping and smoke seal systems capable of supporting anticipated floor loads either by installing floor plates or by other means for floor penetrations with annular spaces exceeding 100 mm in width and exposed to possible loading and traffic.

.3 Provide fire stopping and smoke seal systems not requiring removal of insulation for penetrations involving insulated piping.

.4 Provide products with flame-spread ratings of less than 25 and smoke-developed ratings of less than 50 for fire stopping, smoke seal, and joint systems exposed to view.

.5 Architectural considerations: When fire stop system is exposed to view, consider architectural finish, potential traffic, and exposure to moisture and heat.

.3 Insulated Pipes and Ducts: Design and test listed fire stop system with the actual insulation materials penetrating the fire separation, as indicated on the system design listing.

2.3 MATERIALS

.1 Compatibility: Under conditions of service and application, provide fire stopping and smoke seal systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating the systems, as demonstrated by fire stopping and smoke seal system manufacturer based on testing and site experience, and as follows:

.1 Asbestos-free materials and systems capable of maintaining an effective barrier against the passage of flame, smoke, and water and the transmission of heat in compliance with requirements of CAN-ULC-S115 and not to exceed opening sizes for which they are intended, as indicated on System Design Listing.

.2 Fire Stop System Rating: To match fire-resistance rating of fire separation as indicated on Drawings.

.3 Service penetration assemblies and fire stop components: Certified by testing laboratory to CAN/ULC-S115.

.4 Provide elastomeric seal or non-shrink foam cement mortar for fire and smoke stop systems at openings intended for re-entry, such as cables. Do not use cementitious or rigid seal at such locations.

.5 Provide elastomeric protection for fire and smoke stop systems at openings around penetrations for pipes, ductwork, and other mechanical items requiring sound and vibration control. Do not use a cementitious or rigid seal at such locations. Exemption for fire dampers.

.6 Provide elastomeric seal for fire and smoke seals behind and around mechanical and electrical boxes within wall, floor, and ceiling assemblies.

2.4 FILL MATERIALS

.1 General:

.1 Provide fire stopping and smoke seal systems containing the types of fill materials indicated in SCHEDULE in Part 3 of this Section by reference to the types of materials described in this Article. Fill materials are those referred to in directories of the referenced testing and inspecting agencies as fill, void, or cavity materials.

.2 Fire stopping and smoke seal systems shall be tested in accordance with CAN/ULC-S115 and be comprised of asbestos free materials and systems capable of maintaining an effective barrier against flame, smoke, and gases. Fire stopping and smoke seal systems not to exceed opening sizes for which they are intended for the ratings as indicated on Drawings.

.2 Latex Sealants: Single component latex formulations that after curing do not re-emulsify during exposure to moisture.

.3 Fire Stopping and Smoke Seal Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrating item.

.4 Cable Penetration Devices:

.1 Pre-manufactured intumescent blocks.

.2 Pre-manufactured sleeves, consisting of an adjustable core.

.3 Pre-manufactured cable management system, consisting of a system of intumescent inserts and adjustable cores.

.5 Intumescent Putties: Non-hardening dielectric, water resistant putties containing no solvents, inorganic fibres, or silicone compounds.

.6 Intumescent Spray Foam: Expanding spray-in-place intumescent foam sealant.

.7 Intumescent Wrap Strips: Single component intumescent elastomeric sheets with aluminum foil on one side.

.8 Intumescent, Latex Sealant: Single-component, intumescent, latex formulation.

.9 Job-Mixed Vinyl Compound: Prepackaged vinyl-based powder product for mixing with water at Project site to produce a paintable compound, passing ASTM E136, with flame-spread and smoke-developed ratings of zero per ASTM E84.

.10 Solvent-Release-Curing Intumescent Sealant: Solvent-release-curing, single-component, synthetic-polymer-based sealant of grade indicated below:

.1 Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces. Non-sag formulation for openings in vertical and other surfaces requiring a non-slumping/gunnable sealant, unless indicated fire stop system limits use non-sag grade.

.11 Mortars: Pre-packaged, dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a non-shrinking, homogeneous mortar.

.12 Pillows/Bags: Reusable, heat-expanding pillows/bags consisting of glass fibre cloth cases filled with a combination of mineral fibre, water insoluble expansion agents and fire-retardant additives.

.13 Silicone Foams: Multi-component, silicone based liquid elastomers that, when mixed, expand and cure in-place to produce a flexible, non-shrinking foam.

.14 Silicone Sealants: Moisture curing, single component, silicone based, neutral curing elastomeric sealants of grade indicated below:

.1 Grade for Horizontal Surfaces: Pourable (self-levelling) formulation for openings in floors and other horizontal surfaces.

.2 Grade for Vertical Surfaces: Non-sag formulation for openings in vertical and other surfaces.

.15 Ceramic-Fibre and Mastic Coating: Ceramic fibres in bulk form formulated for use with mastic coating, and ceramic fibre manufacturer's mastic coating.

.16 Ceramic-Fibre Sealant: Single-component formulation of ceramic fibres and inorganic binders.

2.5 MIXING

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

2.6 FIRE-RESISTIVE ELASTOMERIC JOINT SEALANTS

.1 Elastomeric Sealant Standard: Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer that comply with ASTM C920 requirements, including those referenced for Type, Grade, Class, and Uses, and requirements specified in this Section applicable to fire-resistive joint sealants.

.2 Single-Component, Neutral-Curing Silicone Sealant: Type S; Grade NS; Class 25; exposure-related Use NT, and joint-substrate-related Uses M, G, A, and (as applicable to joint substrates indicated) O:

.1 Additional Movement Capability: When tested for adhesion and cohesion under maximum cyclic movement per ASTM C719, provide sealant with the capability to withstand the changes in joint width existing at the time of installation, and remain in compliance with other requirements of ASTM C920.

.3 Multicomponent, Non-sag, Urethane Sealant: Type M; Grade NS; Class 25; exposure-related Use NT, and joint-substrate-related Uses M, A, and (as applicable to joint substrates indicated) O:

.1 Additional Movement Capability: When tested for adhesion and cohesion under maximum cyclic movement per ASTM C719, provide sealant with the capability to withstand the change in joint width existing at the time of installation, and remain in compliance with other requirements of ASTM C920.

.4 Single-Component, Non-sag, Urethane Sealant: Type S; Grade NS; Class 25; and Uses NT, M, A, and (as applicable to joint substrates indicated) O.

2.7 FIRE STOP IDENTIFICATION

.1 Identification Labels and Markings: Permanent for the expected service life of the installation.

.2 Fire Stopped Penetrations:

.1 Provide identification labels at each penetration.

.2 Identification labels: adhesive plastic stickers with the following information:

.1 Penetration number.

.2 Floor number.

.3 Room number.

.4 Product name and number.

.5 System design number.

.6 Fire rating required in hours.

.7 Fire stop contractor's name and phone number.

.8 Installer's name.

.9 Date of installation.

.3 Indicate on label that fill material around the penetration is a fire stop system and shall not be disturbed except by authorized personnel.

2.8 ACCESSORIES

.1 Provide components for each fire stopping and smoke seal system needed to install fill materials. Use only components specified by fire stopping and smoke seal system manufacturer and approved by the qualified testing and inspecting agency for fire stopping and smoke seal systems indicated on Drawings.

.2 Primers: To manufacturer's recommendation for specific material, substrate, and end use.

.3 Water (if applicable): Potable, clean and free from harmful amounts of deleterious substances.

.4 Metal Fire Stop: Commercial galvanized steel, to ASTM A1008/A1008M, zinc coating 260 g/m^2, minimum metal core thickness 0.912 mm.

.5 Packing/Damming Materials, Supports, and Anchoring Devices: To manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to AHJ.

.6 Fire Stop Insulation: Pre-formed, semi-rigid, non-combustible mineral wool, pre-cut in 1,220 mm lengths to required depth and width.

.7 Junction Box/Outlet Sealing Putty: Intumescent putty, pre-formed in pads.

.8 Sealants: Good adhesion without use of primer, high visibility safety colours:

.1 Flame-spread rating: Maximum 25.

.2 Smoke development classification: Maximum 50.

.3 For vertical joints: Non-sagging.

.4 For horizontal joints: Single component, self-levelling.

Part 3 Execution

3.1 EXAMINATION

.1 Verify that conditions of substrates previously installed are acceptable for product installation in accordance with manufacturer's instructions and approved system design listings for each condition.

.2 Verify each opening/annular space to ensure it does not exceed the maximum and minimum dimensions indicated on the approved system design listing.

.3 Verify that all joints, service penetrating elements, and supporting devices/hangers have been properly installed as indicated on approved system design listings. Remove all temporary lines and markings to meet the approved system design listings.

.4 Verify that proposed fire stop system consists of components that are compatible with each other, with substrates forming the openings, and with items, if any, penetrating the fire stop under conditions of application and service, as demonstrated by the fire stop manufacturer based on testing and site experience.

.5 Pipe and Duct Insulation: Confirm that proposed fire stop system has been tested with the actual insulation penetrating the fire separation on site, as indicated in the approved

system design listing. Maintain insulation around pipes and ducts penetrating the fire separation.

.6 Ensure no additional items have been installed through opening that does not appear on the approved system design listing.

.7 Ensure fire stopped areas are accessible for proper application and that conditions are suitable for installation of the fire stop system. Areas to remain accessible for inspection.

.8 Report in writing to the HRCE Representative any defective surfaces or conditions affecting the fire stop system installation immediately and before commencing any installations.

.9 Proceed only once defected surfaces or conditions have been corrected.

.10 Proceed with installation only after unacceptable conditions have been remedied.

3.2 PREPARATION

.1 Examine sizes and conditions of voids to be filled to establish correct thicknesses and installation of materials:

.1 Ensure that substrates and surfaces are clean, dry, and frost free.

.2 Ensure substrates and surfaces are free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.

.2 Prepare surfaces in contact with fire stop and smoke stop materials to manufacturer's instructions.

.3 Maintain insulation around pipes and ducts penetrating fire separation without interruption to vapour barrier.

.4 Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.

.5 Protect adjacent work areas and finish surfaces from damage during product installation.

.6 Prime surfaces as required.

.7 Ensure multi-penetration openings have been framed and boarded out around annular openings, as indicated in the system design listing before prepping the opening.

3.3 INSTALLATION

.1 Install fire stop and smoke seal materials and components in accordance with manufacturer's certified tested system listing.

.2 Coordinate with other sub-trades to ensure that all pipes, conduits, cables, and other items, which penetrate fire separations, have been permanently installed before installation of fire stop systems.

.3 Schedule work to ensure that fire separations and all other construction that conceals penetrations are not erected before installation of fire and smoke seal systems.

.4 Seal holes or voids made by through-penetrations, poke-through termination devices, and un-penetrated openings or joints to ensure that both continuity and integrity of fire separation are maintained.

.5 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing per manufacturer's instructions.

.6 Tool or trowel exposed surfaces to neat finish.

.7 Remove excess compound promptly as work progresses and upon completion.

.8 Protect gaps around recessed components (e.g. panels, electrical boxes, outlets) with sealing putty in accordance with manufacturer's instructions.

.9 Do not use damaged or expired material.

3.4 INSTALLATION - THROUGH PENETRATION JOINT SEALANTS

.1 Install forming/damming materials and other accessories of types required to support fill materials during their application and in the position required to achieve fire ratings of designated through-penetration fire stop systems.

.2 Install fill materials for through-penetration fire stop systems by techniques recommended by the manufacturer to produce the following results:

.1 Completely fill voids and cavities formed by openings, forming materials, accessories, and penetrating items.

.2 Apply materials so they contact and adhere to substrates formed by openings and penetrating items.

.3 For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

.3 Remove combustible forming materials and other accessories not indicated as permanent components of fire stop systems.

3.5 IDENTIFICATION

.1 General:

.1 Clean substrate before applying identification.

.2 Determine final location of identification on site.

.3 Identification is not required on both sides of the fire separation.

.4 Refer to Drawings for locations of fire separations and rating required.

.2 Fire Stopped Penetrations:

.1 Install identification label adjacent to each fire stopped wall/floor service penetration. Provide one identification label per single opening or per grouping cluster.

.2 Securely apply identification to substrate by providing adequate adhesive.

.3 Secure tags with metal fasteners or hang with metal chain or wire.

.4 Identification shall be completely filled out and installed before requesting substantial performance.

3.6 REPAIRS AND MODIFICATIONS

.1 Identify damaged or re-entered seals requiring repair or modification.

.2 Remove loose or damaged materials. If adding penetrating items, remove sufficient material to insert new elements and to avoid damaging the balance of the seal.

.3 Ensure sealed surfaces are clean and dry.

.4 Use only materials that are suitable for repair of original seal, as approved by manufacturer. Do not mix products from different manufacturers.

3.7 SITE QUALITY CONTROL

.1 Inspections: Notify the HRCE Representative when ready for inspection and before concealing or enclosing fire stop materials and service penetration assemblies.

3.8 INSPECTIONS

.1 The HRCE Representative is to conduct random inspections and direct exploratory review (i.e. destructive testing) during the course of construction and before closing off any concealed areas. Perform inspections and destructive testing in compliance with ASTM E2174 and ASTM E2393:

.1 Include a minimum of 2% of each 900 m^2 area for exploratory reviews for each approved system design listing and each trade involved. Perform cut tests at perimeter joints every 15 meters. Perform cut test at bottom and top of wall joints and wall-to-wall joints, and building expansion joints every 15 meters.

.2 Perform exploratory review as directed by the HRCE Representative. Cut out fire stop and remove to ensure fire stop system installation meets or exceeds the system design listing as identified.

.2 Submit formal request for substantial performance review of work once all work is completed, quality control has been performed and all fire stop installations have been inspected and identified with the approved fire stop identification labels.

3.9 CLEANING

.1 Perform cleaning in accordance with Section 01 74 00 - Cleaning.

.2 Remove equipment, excess materials, and debris, and clean adjacent surfaces immediately after application. Use methods and cleaning materials approved by manufacturer.

.3 Protect fire stops during and after curing period from contact with contaminating substances

.4 Remove temporary dams after initial set of fire stop and smoke seal materials.

3.10 SCHEDULE

.1 Provide fire stop and L-Rated smoke-resistant fire stop systems at locations shown on Drawings and as indicated on Drawing schedules and details.

.2 Design and provide through-penetration fire stopping and smoke seals as follows:

.1 Systems with no penetrating items, select one or more of the following fill materials:

.1 Latex sealant.

.2 Silicone sealant.

.3 Intumescent putty.

.4 Intumescent foam blocks or boards.

.5 Intumescent spray foam.

.2 Systems for metallic pipes, conduit, or tubing, select one or more of the following fill materials:

.1 Latex sealant.

.2 Silicone sealant.

.3 Intumescent putty.

.4 Intumescent foam blocks or boards.

.5 Intumescent spray foam.

.3 Systems for non-metallic pipe, conduit, or tubing, select one or more of the following fill materials:

.1 Latex sealant.

.2 Silicone sealant.

.3 Intumescent putty.

.4 Intumescent foam blocks or boards.

.5 Intumescent spray foam.

.4 Systems for electrical, data, and communications cables, select one or more of the following fill materials:

.1 Latex sealant.

.2 Silicone sealant.

.3 Intumescent putty.

.4 Silicone foam.

.5 Prefabricated fire stop sleeve cp 653 (hilti).

.6 Preformed intumescent blocks cfs-bl (hilti).

.7 Preformed intumescent blocks (roxtec).

.8 Prefabricated cable pathways (ez-path).

.9 Intumescent foam blocks or boards.

.10 Intumescent spray foam.

.5 Systems for insulated pipes, select one or more of the following fill materials:

.1 Latex sealant.

.2 Intumescent putty.

.3 Silicone foam.

.4 Intumescent wrap strips.

.5 Intumescent foam blocks or boards.

.6 Intumescent spray foam.

.6 Systems for miscellaneous electrical penetrations, select one or more of the following fill materials:

.1 Latex sealant.

.2 Intumescent putty.

.3 Intumescent foam blocks or boards.

.4 Intumescent spray foam.

.7 Systems for miscellaneous mechanical penetrations, select one or more of the following fill materials:

.1 Latex sealant.

.2 Intumescent foam blocks or boards.

.3 Intumescent spray foam.

.8 Systems for groupings of penetrations, select one or more of the following fill materials:

.1 Latex sealant.

.2 Intumescent wrap strips.

.3 Fire stopping and smoke seal device.

.4 Intumescent composite sheet.

.5 Intumescent foam blocks or boards.

.6 Intumescent spray foam.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 03 30 00 - Cast-in-Place Concrete: Sealants required in conjunction with cast-in-place concrete.

.2 Section 07 84 00 - Firestopping: Sealants required in conjunction with firestopping.

1.2 REFERENCE STANDARDS

.1 ASTM C834-17 Standard specification for latex sealants.

.2 ASTM C920-18 Standard specification for elastomeric joint sealants.

.3 ASTM C1184-23 Standard specification for structural silicone sealants.

.4 ASTM C1193-16 Standard guide for use of joint sealants.

.5 ASTM C1311-22 Standard specification for solvent release sealants.

.6 ASTM C1330-23 Standard specification for cylindrical sealant backing for use with cold liquid-applied sealants.

.7 ASTM C1401-23 Standard guide for structural sealant glazing.

.8 ASTM C1481-12 Standard guide for use of joint sealants with exterior insulation and finish systems (EIFS).

1.3 ACTION SUBMITTALS

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide data indicating sealant chemical characteristics, performance criteria, substrate preparation, limitations, and colour availability.

1.4 INFORMATIONAL SUBMITTALS

.1 Section 01 33 00 - Submittal Procedures.

.2 Installation Data: Manufacturer's special installation requirements.

1.5 SITE CONDITIONS

.1 Ambient Conditions:

.1 Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.6 WARRANTY

.1 Section 01 78 00 - Closeout Submittals.

.2 Warranty: Provide a five (5) year warranty for failure to meet specified requirements including coverage for installed sealants and accessories which fail to achieve water tight seal, exhibit loss of adhesion or cohesion, or do not cure.

.3 Manufacturer's Warranty: Provide manufacturer's twenty (20) year material warranty for installed silicone sealant.

Part 2 Products

2.1 PERFORMANCE/DESIGN CRITERIA

.1 Sealant Design: Design structural sealant to withstand specified loads without breakage, loss, failure of seals, product deterioration, and other defects.

.2 Design installed sealant to withstand:

.1 Loads: Design and size to withstand dead and live loads caused by positive and negative wind pressure acting normal to plane of panel:

.1 As calculated in accordance with applicable code.

.2 As measured in accordance with ASTM E330/E330M.

.2 Movement from ambient temperature range of 49 °C.

.3 Movement and deflection of structural support framing.

.4 Water and air penetration.

2.2 SEALANTS

.1 Bituminous Based (Type B): Single component, asphalt compound, elongation capability of 0% to 2% of joint width.

.2 Acrylic Emulsion Latex (Type C): ASTM C834, Type C; single component, non-staining, non-bleeding, non-sagging:

.1 Elongation Capability 2% to 5%.

.2 Service Temperature Range -17 to 71 °C.

.3 Shore A Hardness Range 15 to 40.

.3 Acrylic Sealant (Type D): ASTM C920; single component, solvent curing, non-staining, non-bleeding, non-sagging; colour: as selected:

.1 Elongation Capability 7.5% to 12%.

.2 Service Temperature Range -17 to 71 °C.

.3 Shore A Hardness Range 25 to 50.

.4 Silicone Sealant (Type M): ASTM C920; multi-component, neutral curing, non-sagging, non-staining, non-bleeding:

.1 Elongation Capability 25%.

.2 Service Temperature Range -54 to 82 °C.

.3 Shore A Hardness Range 15 to 35.

.5 Sanitary Silicone Sealant (Type N): ASTM C920, Grade NS, Class 25, Use NT; single component, acetoxy curing, non-sagging, non-staining, mildew resistant; colour as selected:

.1 Elongation Capability 25%.

.2 Service Temperature Range -54 to 82 °C.

.3 Shore A Hardness Range 15 to 35.

2.3 ACCESSORIES

.1 Primer: Non-staining type, as recommended by sealant manufacturer to suit application.

.2 Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.

.3 Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

.4 Masking tape: Non-staining, non-absorbent type compatible with sealant and adjacent surfaces.

.5 Setting Blocks and Spacers: Compatible with silicone sealant and recommended by sealant manufacturer.

Part 3 Execution

3.1 PREPARATION

.1 Remove loose materials and foreign matter which might impair adhesion of sealant.

.2 Clean and prime joints to sealant manufacturer's written instructions.

.3 Perform preparation to sealant manufacturer's written instructions.

.4 Protect elements surrounding the work of this section from damage or disfiguration.

3.2 INSTALLATION

.1 Install sealant to sealant manufacturer's written instructions.

.2 Measure joint dimensions and size materials to achieve required width/depth ratios.

.3 Install bond breaker where joint backing is not used.

.4 Install sealant free of air pockets, foreign embedded matter, ridges, and sags.

.5 Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

.6 Tool joints concave.

3.3 FIELD QUALITY CONTROL

.1 Inspection and Testing:

.1 Joint Sealants: Perform adhesion tests to manufacturer's written instructions and ASTM C1193, Method A - Field-Applied Sealant Joint Hand Pull Tab.

.2 Remove sealants failing adhesion test, clean substrates, reinstall sealants, and perform retesting.

.3 Maintain test log and submit report to the HRCE Representative indicating tests, locations, dates, results, and remedial actions.

.2 Manufacturer's Services:

.1 Monitor and report installation procedures and unacceptable conditions.

3.4 CLEANING

.1 Section 01 74 00 - Cleaning installed work.

.2 Clean adjacent soiled surfaces.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Submit manufacturer's instructions, printed product literature, and data sheets for all plumbing fixtures and equipment, and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Indicate on drawings:

.1 Mounting arrangements.

.2 Operating and maintenance clearances.

.3 Shop drawings and product data accompanied by:

.1 Detailed drawings of bases, supports, and anchor bolts.

.2 Acoustical sound power data, where applicable.

.3 Points of operation on performance curves.

.4 Manufacturer to certify current model production.

.5 Certification of compliance to applicable codes.

.4 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.

1.2 CLOSEOUT SUBMITTALS

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

.2 Operation and Maintenance Data: submit operation and maintenance data for all plumbing fixtures and equipment for incorporation into manual:

.1 Operation and maintenance manual approved by, and final copies deposited with, HRCE Representative before final inspection.

.2 Operation data to include:

.1 Control schematics for systems including environmental controls.

.2 Description of systems and their controls.

.3 Description of operation of systems at various loads together with reset schedules and seasonal variances.

.4 Operation instruction for systems and component.

.5 Description of actions to be taken in event of equipment failure.

.6 Valves schedule and flow diagram.

.7 Colour coding chart.

.3 Maintenance data to include:

.1 Servicing, maintenance, operation, and trouble-shooting instructions for each item of equipment.

.2 Data to include schedules of tasks, frequency, tools required, and task time.

.4 Performance data to include:

.1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.

.2 Equipment performance verification test results.

.3 Special performance data as specified.

.4 Testing, adjusting, and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.5 Approvals:

.1 Submit 2 copies of draft Operation and Maintenance Manual to HRCE Representative for approval. Submission of individual data will not be accepted unless directed by HRCE Representative.

.2 Make changes as required and re-submit as directed by HRCE Representative.

.6 Additional data:

.1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.

.7 Site records:

.1 HRCE Representative will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems, and low voltage control wiring.

.2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.

.3 Use different colour waterproof ink for each service.

.4 Make available for reference purposes and inspection.

.8 As-built drawings:

.1 Prior to start of Testing, Adjusting, and Balancing for HVAC, finalize production of as-built drawings.

.2 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)".

.3 Submit to HRCE Representative for approval and make corrections as directed.

.4 Perform testing, adjusting, and balancing for HVAC using as-built drawings.

.5 Submit completed reproducible as-built drawings with Operations and Maintenance Manuals.

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

1.3 MAINTENANCE MATERIAL SUBMITTALS

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

.2 Furnish spare parts as follows:

.1 One set of packing for each pump.

.2 One casing joint gasket for each size pump.

.3 One glass for each gauge glass.

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

.4 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment, 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 indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect all plumbing fixtures and equipment from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return of all packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for plumbing fixture and equipment installation in accordance with manufacturer's written instructions:

.1 Visually inspect substrate in presence of HRCE Representative.

.2 Inform HRCE Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from HRCE Representative.

3.2 PAINTING REPAIRS AND RESTORATION

.1 Prime and touch up marred finished paintwork to match original.

.2 Restore to new condition, finishes which have been damaged.

3.3 SYSTEM CLEANING

.1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.

3.4 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

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

3.5 DEMONSTRATION

.1 Supply tools, equipment, and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting, and servicing of all systems and equipment during regular work hours, prior to acceptance.

.2 Use Operation and Maintenance Manual, as-built drawings, and audio visual aids as part of instruction materials.

.3 Instruction duration time requirements as specified in appropriate sections.

3.6 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.

3.7 PROTECTION

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

END OF SECTION

Part 1 General

1.1 DEFINITIONS

.1 Demolish: Detach items from existing construction and legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.

.2 Remove: Planned deconstruction and disassembly of electrical items from existing construction including removal of conduit, junction boxes, cabling and wiring from electrical component to panel taking care not to damage adjacent assemblies designated to remain; legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.

.3 Remove and Salvage: Detach items from existing construction and deliver them to HRCE Representative ready for reuse.

.4 Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.

.5 Existing to Remain: Existing items of construction that are not removed and that are not otherwise indicated as being removed and salvaged, or removed and reinstalled.

.6 Hazardous Substances: Dangerous substances, dangerous goods, hazardous commodities and hazardous products may include asbestos, mercury and lead, PCB's, poisons, corrosive agents, flammable substances, radioactive substances, or other material that can endanger human health or wellbeing or environment if handled improperly as defined by the Federal Hazardous Products Act (RSC 1985) including latest amendments.

1.2 REFERENCE STANDARDS

.1 CSA Group (CSA):

.1 CSA S350 M1980 (R2003), Code of Practice for Safety in Demolition of Structures.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Action Submittals: Provide the following in accordance with Section 01 33 00 - Submittal Procedures before starting work of this Section:

.1 Construction Waste Management Plan (CWM Plan): Submit plan addressing opportunities for reduction, reuse, or recycling of materials prepared in accordance with Section 01 74 19 - Waste Management and Disposal

.2 Landfill Records: Indicate receipt and acceptance of selective demolition waste and hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.4 ADMINISTRATIVE REQUIREMENTS

.1 Coordination: Coordinate work of this Section to avoid interference with work by other Sections.

.2 Scheduling: Account for Owner's continued occupancy requirements during selective demolition and schedule staged occupancy and worksite activities.

1.5 SITE CONDITIONS

.1 Existing Conditions: Condition of materials identified as being salvaged or demolished are based on their observed condition at time of site examination before tendering.

.2 Discovery of Hazardous Substances: It is not expected that Hazardous Substances will be encountered in the Work; immediately notify HRCE Representative if materials suspected of containing hazardous substances are encountered and perform the following activities:

.1 Refer to Section 01 41 00 - Regulatory Agencies for directives associated with specific material types.

.2 Hazardous substances will be as defined in the Hazardous Products Act.

.3 Stop work in the area of the suspected hazardous substances.

.4 Take preventative measures to limit users and workers exposure, provide barriers and other safety devices, and do not disturb.

.5 Hazardous substances will be removed by HRCE Representative under a separate contract or as a change to the Work.

.6 Proceed only after written instructions have been received from HRCE Representative.

1.6 SALVAGE AND DEBRIS MATERIALS

.1 Demolished items become Contractor's property and will be removed from Project site; except for items indicated as being reused, salvaged, or otherwise indicated to remain.

.2 Carefully remove materials and items designated for salvage and store in a manner to prevent damage or devaluation of materials.

Part 2 Products

2.1 MATERIALS

.1 Plumbing Repair Materials: Use only new materials required for completion or repair matching materials damaged during performance of work of this Section; new materials are required to meet assembly or system characteristics as existing systems indicated to remain and carry CSA approval labels required by the Authority Having Jurisdiction

.2 Fire stopping Repair Materials: Use fire stopping materials compatible with existing fire stopping systems where removal or demolition work affects rated assemblies, restore to match existing fire rated performance.

Part 3 Execution

3.1 EXAMINATION

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

3.2 PREPARATION

.1 Protection of Existing Systems to Remain: Protect systems and components indicated to remain in place during selective demolition operations and as follows:

.1 Prevent movement and install bracing to prevent settlement or damage of adjacent services and parts of existing buildings scheduled to remain.

.2 Notify HRCE Representative and cease operations where safety of buildings being demolished, adjacent structures, or services appears to be endangered, and await additional instructions before resuming demolition work specified in this Section.

.3 Prevent debris from blocking drainage inlets.

.4 Protect mechanical systems that must remain in operation.

.2 Protection of Building Occupants: Sequence demolition work so that interference with the use of the building by the HRCE Representative and users is minimized and as follows:

.1 Prevent debris from endangering the safe access to and egress from occupied buildings.

.2 Notify HRCE Representative and cease operations where safety of occupants appears to be endangered and await additional instructions before resuming demolition work specified in this Section.

3.3 EXECUTION

.1 Demolition and Removal: Coordinate requirements of this Section with information as follows:

.1 Disconnect and cap mechanical services in accordance with requirements of local Authority Having Jurisdiction.

.2 Do not disrupt active or energized utilities without approval of the HRCE Representative.

.3 Erect and maintain dust proof and weather tight partitions to prevent the spread of dust and fumes to occupied building areas; remove partitions when complete.

.4 Demolish parts of existing building to accommodate new construction and remedial work as indicated.

.5 At end of each day's work, leave worksite in safe condition.

.6 Perform demolition work in a neat and workmanlike manner:

.1 Remove any tools or equipment after completion of work, and leave site clean and ready for subsequent renovation work.

.2 Repair and restore damages caused as a result of work of this Section to match existing materials and finishes.

3.4 CLOSEOUT ACTIVITIES

.1 Demolition Waste Disposal: Arrange for legal disposal and remove demolished materials to accredited Provincial landfill site or alternative disposal site (recycle centre) except where explicitly noted otherwise for materials being salvaged for re-use in new construction.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE REQUIREMENTS

.1 Pre-installation Meetings:

.1 Convene pre-installation meeting 1 week prior to beginning work of this Section, with HRCE Representative in accordance with Section 01 31 19 - Project Meetings to:

.1 Verify project requirements.

.2 Review installation and substrate conditions.

.3 Co-ordination with other building construction subtrades.

.4 Review manufacturer's written installation instructions and warranty requirements.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Submit manufacturer's instructions, printed product literature, and data sheets for all plumbing fixtures and equipment, and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Indicate on drawings to indicate materials, finishes, dimensions construction, assembly details, and accessories for following: all plumbing specialties and accessories.

.3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.4 Instructions: submit manufacturer's installation instructions.

.5 Manufacturer's Field Reports: manufacturer's field reports specified.

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 plumbing specialties and accessories for incorporation into manual:

.1 Description of plumbing specialties and accessories, giving manufacturer's name, type, model, year, and capacity.

.2 Details of operation, servicing, and maintenance.

.3 Recommended spare parts list.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment, 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 indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect plumbing materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return of all packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 CLEANOUTS

.1 Cleanouts shall be full size for pipe sizes up to 100 mm and not less than 100 mm on larger sizes. Cleanouts in inside finished areas shall all be of the same shape either round or square.

.2 Cleanouts passing through a waterproofed floor or a slab on grade subject to hydrostatic pressure shall possess a clamping collar which shall be clamped to the floor membrane or lead flashing.

.3 Pipe manufacturer's cleanouts are acceptable for vertical installation at the base of soil and waste stacks or rainwater leaders only.

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

.5 Wall access: face or wall type, stainless steel square cover with flush head securing screws, beveled edge frame complete with anchoring lugs.

.6 Floor access: rectangular 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: cast iron square, gasket, and vandal-proof screws.

2.2 WATER MAKE-UP ASSEMBLY

.1 Complete with backflow preventer pressure gauge on inlet and outlet, pressure reducing valve to CAN/CSA-B356, pressure relief valve on low pressure side and gate valves on inlet and outlet

2.3 STRAINERS

.1 860 kPa, Y type with 20 mesh, monel, bronze, or stainless steel removable screen.

.2 NPS 2 and under, bronze body, screwed ends, with brass cap.

.3 NPS 2 1/2 and over, cast iron body, flanged ends, with bolted cap.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for plumbing specialties and accessories installation in accordance with manufacturer's written instructions:

- .1 Visually inspect substrate in presence of HRCE Representative.
- .2 Inform HRCE Representative of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from HRCE Representative.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 INSTALLATION

.1 Install in accordance with the National Plumbing Code of Canada (NPC), Provincial codes, and local Authority Having Jurisdiction.

.2 Install in accordance with manufacturer's instructions and as specified.

3.4 STRAINERS

.1 Install with sufficient room to remove basket for maintenance.

3.5 WATER MAKE-UP ASSEMBLY

.1 Install on valved bypass.

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

3.6 START-UP

.1 General:

- .1 In accordance with Section 01 91 13 - General Commissioning Requirements: General Requirements, supplemented as specified herein.

.2 Timing: start-up only after:

- .1 Pressure tests have been completed.
- .2 Disinfection procedures have been completed.
- .3 Certificate of static completion has been issued.
- .4 Water treatment systems operational.

.3 Provide continuous supervision during start-up.

3.7 TESTING AND ADJUSTING

.1 General:

.1 Test and adjust plumbing specialties and accessories in accordance with Section 01 91 13 - General Commissioning Requirements: General Requirements, supplemented as specified.

.2 Timing:

.1 After start-up deficiencies rectified.

.2 After certificate of completion has been issued by Authority Having Jurisdiction.

.3 Application tolerances:

.1 Pressure at fixtures: +/- 70 kPa.

.2 Flow rate at fixtures: +/- 20%.

.4 Adjustments:

.1 Verify that flow rate and pressure meet design criteria.

.2 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 Cleanouts:

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

.6 Strainers:

.1 Clean out repeatedly until clear.

.2 Verify accessibility of cleanout plug and basket.

.3 Verify that cleanout plug does not leak.

.7 Hydronic system water Make-up Assembly:

.1 Verify flow, pressure, and connection.

3.8 CLOSEOUT ACTIVITIES

.1 Commissioning Reports: in accordance with Section 01 91 13 - General Commissioning Requirements: reports, supplemented as specified.

.2 Training: provide training in accordance with Section 01 91 13 - General Commissioning Requirements: Training of O&M Personnel, supplemented as specified.

3.9 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 in accordance with Section 01 74 19 - Waste Management and Disposal:

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

3.10 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by plumbing specialties and accessories installation.

END OF SECTION

Part 1 General

1.1 DEFINITIONS

.1 For the purposes of this Section:

.1 Concealed means insulated mechanical services in suspended ceilings, or in non-accessible chases, or in furred-in spaces.

.2 Exposed means not concealed.

.3 Jacketing is synonymous with insulation cladding and lagging.

.4 Mineral fibre is synonymous with glass fibre, rock wool, or slag wool.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Submit a schedule with a list of insulation for each service location, insulation type, thickness, and jacketing type.

.2 Submit manufacturer's product literature, specifications, and datasheets. Include product characteristics, performance criteria, and limitations.

1.3 QUALITY ASSURANCE

.1 Qualifications:

.1 Installer: Specialist in performing work of this Section with at least three years successful experience in this type and size of project, member of Thermal Insulation Association of Canada (TIAC).

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment, and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address, and ULC markings.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 DESCRIPTION

.1 Regulatory Requirements:

.1 Combustible piping materials, including adhesives in accordance with CAN/ULC-S102:

.1 Flame-spread rating: Maximum 25.

.2 Smoke developed classification: Maximum 50.

2.2 INSULATION

.1 Thermal conductivity ("k" factor) not to exceed specified values at 24 °C mean temperature when tested in accordance with ASTM C335/C335M.

.2 Type A-1: Rigid moulded mineral fibre without factory-applied vapour retarder jacketing:

.1 Mineral fibre: To CAN/ULC-S702.1.

.2 Maximum "k" factor: To CAN/ULC-S702.1.

.3 Type A-3: Rigid moulded mineral fibre with factory-applied vapour retarder jacketing:

.1 Mineral fibre: To CAN/ULC-S702.1.

.2 Jacketing: To ASTM C921.

.3 Maximum "k" factor: To CAN/ULC-S702.1.

2.3 JACKETING

.1 Polyvinyl Chloride (PVC) Jacketing:

.1 One-piece moulded type and sheet, in accordance with ASTM C921, with pre-formed shapes as required.

.2 Colours: as selected by HRCE Representative from manufacturer's standard colour range.

.3 Minimum service temperature: -20 °C.

.4 Maximum service temperature: 65 °C.

.5 Moisture vapour transmission: Maximum 0.02 perm.

.6 Thickness: 0.51 mm (20 mils).

.7 Fastenings:

.1 Use solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Tacks.

.3 Pressure sensitive vinyl tape in matching colour.

.8 Covering adhesive: Compatible with insulation.

2.4 ACCESSORIES

.1 Tape: Self-adhesive, aluminum, reinforced, minimum 50 mm wide.

.2 Contact Adhesive: Quick setting type.

.3 Canvas Adhesive: Washable.

.4 Tie Wire: Stainless steel, minimum 1.5 mm diameter.

.5 Bands: Stainless steel, 19 mm wide, minimum 0.5 mm thick.

.6 Thermal Insulating and Finishing Cement: To ASTM C449, hydraulic setting type, on mineral wool.

.7 Vapour Retarder Lap Adhesive: Water-based and fire retardant type, compatible with insulation.

.8 Indoor Vapour Retarder Finish: Vinyl emulsion type acrylic, compatible with insulation.

.9 Outdoor Vapour Retarder Finish:

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: Fibrous glass, untreated 305 g/m^2.

Part 3 Execution

3.1 PREPARATION

.1 Verify that pressure testing of piping systems and adjacent equipment is complete, witnessed, and certified.

.2 Verify that surfaces are clean, dry, and free from foreign material.

3.2 INSTALLATION

.1 Install to manufacturer's instructions and in accordance with MICA, NACIIS Manual.

.2 Provide two layers of insulation with staggered joints when required nominal wall thickness exceeds 75 mm.

.3 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.4 Install piping insulation continuous through wall and ceiling openings and sleeves, except where firestopping is required.

.5 Supports and Hangers:

.1 Hangers and supports in accordance with Section 22 05 00 - Common Work Results for Plumbing.

.2 Install hangars and supports outside vapour retarder jacket.

.3 Apply high compressive strength insulation that is suitable for piping service at oversized saddles and shoes where insulation saddles have not been provided.

3.3 INSTALLATION - REMOVABLE PRE-FABRICATED INSULATION AND ENCLOSURES

.1 At valves, flanges, and unions at equipment:

.1 Install components to permit periodic removal and replacement without damage to adjacent insulation.

.2 Install insulation, fastenings, and finishes that are compatible with piping system.

3.4 PIPING INSULATION SCHEDULE

.1 Includes valves, valve bonnets, strainers, flanges, and fittings, unless otherwise specified.

.2 Type: A-1:

.1 Securements: Stainless steel wire at 300 mm on centre.

.2 Seals: Lap seal adhesive, lagging adhesive.

.3 Type: A-3:

.1 Securements: Stainless steel wire at 300 mm on centre.

.2 Seals: Vapour retarder lap seal adhesive, vapour retarder lagging adhesive.

.4 Provide insulation thickness as listed in the following table:

.1 Run-out: Branch piping to individual fixtures not exceeding 4,000 mm long.

.2 Do not insulate exposed run-outs to plumbing fixtures.

Application	Piping Insulation Type	Run-out	Pipe sizes (NPS) to 1	Pipe sizes (NPS) 1 1/4 to 2	Pipe sizes (NPS) 2 1/2 to 4	Pipe sizes (NPS) 5 to 6	Pipe sizes (NPS) 8 & over
Domestic Hot Water Supply or Recirc	A-1	25 mm	25 mm	25 mm	38 mm	38 mm	38 mm
Domestic Cold Water Supply	A-3	25 mm	25 mm	25 mm	25 mm	25 mm	25 mm

.5 Finishes:

.1 Exposed indoors: PVC jacketing.

.2 Exposed in mechanical rooms: PVC jacketing.

.3 Concealed, indoors: No additional finish.

.4 Finish attachments: Stainless steel bands, at 300 mm on centre.

.5 Seals: Wing.

3.5 SITE QUALITY CONTROL

.1 Non-Conforming Work: Replace insulation where there is damage to the vapour barrier and insulation is saturated with moisture.

3.6 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.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 Health Canada/Workplace Hazardous Materials Information System (WHMIS):

.1 Safety Data Sheets (SDS).

1.2 ADMINISTRATIVE REQUIREMENTS

.1 Pre-Installation Meeting: Convene pre-installation meeting one week prior to beginning work of this Section in accordance with Section 01 31 19 - Project Meetings:

.1 Verify project requirements.

.2 Review installation and substrate conditions.

.3 Coordination with other building subtrades.

.4 Review manufacturer's installation instructions and warranty requirements.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings: Submit shop drawings to indicate:

.1 Submit manufacturer's instructions, printed product literature, and data sheets for all plumbing fixtures and equipment and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Submit WHMIS SDS. Indicate VOCs for adhesive and solvents during application and curing.

.3 Equipment, including connections, fittings, control assemblies, and ancillaries. Identify whether factory or site assembled.

.4 Wiring and schematic diagrams.

.5 Dimensions and recommended installation.

.6 Pump performance and efficiency curves.

.3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.4 Instructions: submit manufacturer's installation instructions.

.5 Manufacturer's Site Reports: manufacturers' site reports specified.

1.4 CLOSEOUT SUBMITTALS

.1 Submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals, include:

.1 Manufacturers name, type, model year, capacity, and serial number.

.2 Details of operation, servicing, and maintenance.

.3 Recommended spare parts list with names and addresses.

1.5 DELIVERY, STORAGE, AND HANDLING

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

Part 2 Products

2.1 DOMESTIC WATER CIRCULATION PUMPS

.1 Variable speed Electronically Commutated Motor (ECM) pump designed for circulating liquids in domestic water systems. Stainless-steel threaded connections with terminal box for HWR application.

Part 3 Execution

3.1 INSTALLATION

.1 Make piping and electrical connections to pump and motor assembly and controls as indicated.

.2 Ensure pump and motor assembly do not support piping.

.3 Align vertical pit mounted pump assembly after mounting and securing cover plate.

.4 Place 150 mm sand under sump pit tank.

3.2 SITE QUALITY CONTROL

.1 Site Tests/Inspection:

.1 Check power supply.

.2 Check starter protective devices.

.2 Start-up and check for proper and safe operation.

.3 Check settings and operation of hand-off-auto selector switch, operating, safety, and limit controls, audible and visual alarms, over-temperature, and other protective devices.

.4 Adjust flow from water-cooled bearings.

.5 Adjust impeller shaft stuffing boxes and packing glands.

3.3 START-UP

.1 Refer to Section 01 91 13 - General Commissioning Requirements for commissioning requirements.

.2 General: In accordance with Section 01 91 13 - General Commissioning Requirements: General Requirements, supplemented as specified herein.

.1 Procedures:

.1 Check power supply.

.2 Check starter O/L heater sizes.

.3 Start pumps, check impeller rotation.

.4 Check for safe and proper operation.

.5 Check settings, operation of operating, limit, safety controls, over-temperature, audible/visual alarms, and other protective devices.

.6 Test operation of hands-on-auto switch.

.7 Test operation of alternator.

.8 Adjust leakage through water-cooled bearings.

.9 Adjust shaft stuffing boxes.

.10 Adjust leakage flow rate from pump shaft stuffing boxes to manufacturer's recommendations.

.11 Check base for free-floating, no obstructions under base.

.12 Run-in pumps for 12 continuous hours.

.13 Check installation, operation of mechanical seals, and packing gland type seals. Adjust as necessary.

.14 Adjust alignment of piping and conduit to ensure full flexibility.

.15 Eliminate causes of cavitation, flashing, and air entrainment.

.16 Measure pressure drop across strainer when clean and with flow rates as finally set.

.17 Replace seals if pump used to degrease system or if pump used for temporary heat.

.18 Verify lubricating oil levels.

3.4 PERFORMANCE VERIFICATION (PV)

.1 General: In accordance with Section 01 91 13 - General Commissioning Requirements: General Requirements, supplemented as specified.

.2 Obtain manufacturer's approval, before performing PV, to ensure warranties remain intact.

.3 Application tolerances:

.1 Flow: +/- 10%.

.2 Pressure: Plus 20%, minus 5%.

.4 PV procedures:

.1 Open pump balancing valve fully.

.2 Measure Differential Pressure (DP) across pump.

.3 Measure amperage and voltage and compare with manufacturer's data sheets and motor nameplate data.

.4 If suction is different size than discharge connection, add velocity head correction factor to DP.

.5 Mark this DP on manufacturer's pump curve.

.6 If flow rate is higher than specified, slow close balancing valve until specified DP is reached.

.7 Repeat measurements of amps and volts. Compare with manufacturer's data sheets.

.8 Calculate BHP and compare with nameplate data.

3.5 REPORTS

.1 In accordance with Section 01 91 13 - General Commissioning Requirements: reports, supplemented as specified. Include:

.1 PV results on approved PV Report Forms.

.2 Product Information report forms.

.3 Pump performance curves (family of curves) with final point of actual performance.

3.6 TRAINING

.1 In accordance with Section 01 91 13 - General Commissioning Requirements: Training of O&M personnel, supplemented as specified.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers International (ASME):

- .1 ANSI/ASME B16.15-13, Cast Cooper Alloy Threaded Fittings, Classes 125 and 250.
- .2 ANSI/ASME B16.18-12, Cast Copper Alloy Solder Joint Pressure Fittings.
- .3 ANSI/ASME B16.22-13, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- .4 ANSI/ASME B16.24-11, Cast Copper Alloy Pipe Flanges and Flanged Fittings: Class 150, 300, 400, 600, 900, 1500, and 2500.
- .5 ASME B16.26-13, Cast Copper Alloy Fittings for Flared Copper Tubes.
- .6 ASME B31.9-14, Building Services Piping.
- .7 ASME B36.19M-04, Stainless Steel Pipe.

.2 ASTM International (ASTM):

- .1 ASTM A182/A 182M-16, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
- .2 ASTM A269-15a, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
- .3 ASTM A307-14, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- .4 ASTM A312/A312M-16, Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
- .5 ASTM A351/A351M-16, Castings, Austenitic, for Pressure Containing Parts.
- .6 ASTM A403/A403M-16, Wrought Austenitic Stainless Steel Piping Fittings.
- .7 ASTM A536-84(2014), Standard Specification for Ductile Iron Castings.
- .8 ASTM B32-08(2014), Standard Specification for Solder Metal.
- .9 ASTM B42-15a, Seamless Copper Tube, Standard Sizes.
- .10 ASTM B88M-14, Standard Specification for Seamless Copper Water Tube (Metric).

.3 American National Standards Institute/American Water Works Association (ANSI)/(AWWA):

- .1 ANSI/AWWA C111/A21.11-12, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .2 ANSI/AWWA C151/A21.51-09, Ductile Iron Pipe, Centrifugally Cast, for Water.

.4 CSA Group (CSA):

- .1 CSA B242-05, Groove and Shoulder Type Mechanical Pipe Couplings.

.5 Department of Justice Canada (Jus):

.1 Canadian Environmental Protection Act, 1999, c. 33 (CEPA).

.6 Health Canada/Workplace Hazardous Materials Information System (WHMIS):

.1 Safety Data Sheets (SDS).

.7 Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS):

.1 MSS-SP-67-02a, Butterfly Valves.

.2 MSS-SP-70-06, Grey Iron Gate Valves, Flanged and Threaded Ends.

.3 MSS-SP-71-05, Grey Iron Swing Check Valves, Flanged and Threaded Ends.

.4 MSS-SP-80-03, Bronze Gate, Globe, Angle and Check Valves.

.8 National Research Council (NRC):

.1 National Plumbing Code of Canada (NPC) 2020.

.9 Transport Canada (TC):

.1 Transportation of Dangerous Goods Act, 1992, c. 34 (TDGA).

.10 ULC Standards (ULC):

.1 CAN/ULC S101-07, Fire Endurance Tests of Buildings Construction and Materials.

.2 CAN/ULC S102.2-10, Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings and Miscellaneous Materials and Assemblies.

.3 CAN/ULC S115-11, Standard Method of Fire Tests of Firestop.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data: Provide manufacturer's product literature and datasheets for insulation and adhesives. Include product characteristics, performance criteria, physical sizes, finishes, and limitations.

1.3 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packaging Waste Management: remove for reuse and return of all packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 PIPING

.1 Domestic hot, cold and recirculation systems, within building:

.1 Above ground:

.1 Copper tube, hard drawn, type L: to ASTM B88M.

2.2 FITTINGS

.1 Bronze pipe flanges and flanged fittings, Class 150 and 300: to ANSI/ASME B16.24.

.2 Cast bronze threaded fittings, Class 125 and 250: to ANSI/ASME B16.15.

.3 Cast copper, solder type: to ANSI/ASME B16.18.

.4 Wrought copper and copper alloy, solder type: to ANSI/ASME B16.22.

.5 NPS 2 and larger:

.1 ANSI/ASME B16.18 or ANSI/ASME B16.22 roll grooved to CSA B242.

.6 NPS 1 ½ and smaller:

.1 Wrought copper to ANSI/ASME B16.22; with 301 stainless steel internal components and EPDM seals. Suitable for operating pressure to 1,380 kPa.

2.3 JOINTS

.1 Rubber gaskets, latex-free 1.6 mm thick: to AWWA C111.

.2 Bolts, nuts, hex head, and washers: to ASTM A307, heavy series.

.3 Solder: 95/5 tin copper alloy.

.4 Teflon tape: for threaded joints.

.5 Grooved couplings: designed with angle bolt pads to provide rigid joint, complete with EPDM gasket.

.6 Dielectric connections between dissimilar metals: dielectric fitting, complete with thermoplastic liner.

2.4 GATE VALVES

.1 NPS 2 and under, screwed:

.1 Rising stem: to MSS-SP-80, Class 125, 860 kPa, bronze body, screw-in bonnet, solid wedge disc as specified Section 23 05 23.01 - Valves - Bronze.

.2 NPS 2 1/2 and over, in mechanical rooms, flanged:

.1 Rising stem: to MSS-SP-70, Class 125, 860 kPa, flat flange faces, cast-iron body, OS&Y bronze trim specified Section 23 05 23.02 - Valves - Cast Iron.

.3 NPS 2 1/2 and over, other than mechanical rooms, flanged:

.1 Non-rising stem: to MSS-SP-70, Class 125, 860 kPa, flat flange faces, cast-iron body, bronze trim, bolted bonnet specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.

2.5 GLOBE VALVES

.1 NPS2 and under, soldered:

.1 To MSS-SP-80, Class 125, 860 kPa, bronze body, renewable composition disc, screwed over bonnet as specified Section 23 05 23.01 - Valves - Bronze.

.2 Lockshield handles: as indicated.

.2 NPS 2 and under, screwed:

.1 To MSS-SP-80, Class 150, 1 MPa, bronze body, screwed over bonnet, renewable composition disc as specified Section 23 05 23.01 - Valves - Bronze.

.2 Lockshield handles: as indicated.

2.6 SWING CHECK VALVES

.1 NPS 2 and under, soldered:

.1 To MSS-SP-80, Class 125, 860 kPa, bronze body, bronze swing disc, screw in cap, regrindable seat as specified Section 23 05 23.01 - Valves - Bronze.

.2 NPS 2 and under, screwed:

.1 To MSS-SP-80, Class 125, 860 kPa, bronze body, bronze swing disc, screw in cap, regrindable seat as specified Section 23 05 23.01 - Valves - Bronze.

.3 NPS 2 1/2 and over, flanged:

.1 To MSS-SP-71, Class 125, 860 kPa, cast iron body, flat flange faces, renewable seat, bronze disc, bolted cap specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.

2.7 BALL VALVES

.1 NPS 2 and under, screwed:

.1 Class 150.

.2 Bronze body, stainless steel ball, PTFE adjustable packing, brass gland and PTFE seat, steel lever handle as specified Section 23 05 23.01 - Valves - Bronze.

Part 3 Execution

3.1 INSTALLATION

.1 Install in accordance with NPC.

.2 Install pipe work in accordance with Section 23 05 15 - Common Installation Requirements for HVAC Pipework, supplemented as specified herein.

.3 Assemble piping using fittings manufactured to ANSI and Standard Council of Canada (SCC) standards

.4 Install CWS piping below and away from HWS and HWC and other hot piping so as to maintain temperature of cold water as low as possible.

.5 Connect to fixtures and equipment in accordance with manufacturer's written instructions unless otherwise indicated.

.6 Valves:

.1 Isolate equipment, fixtures, and branches with ball valves.

.2 Balance recirculation system using lockshield globe valves. Mark settings and record on as-built drawings on completion.

3.2 PRESSURE TESTS

.1 Test pressure: greater of 1 times maximum system operating pressure or 860 kPa.

3.3 FLUSHING AND CLEANING

.1 Flush entire system for 8 hours. Ensure outlets flushed for 2 hours. Let stand for 24 hours, then draw one sample off longest run. Submit to testing laboratory to verify that

system is clean Federal potable water guidelines. Let system flush for additional 2 hours, then draw off another sample for testing.

3.4 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 and expansion compensators are installed properly.

3.5 DISINFECTION

.1 Flush out, disinfect, and rinse system to HRCE Representative.

.2 Upon completion, provide laboratory test reports on water quality for HRCE Representative approval.

3.6 START-UP

.1 Timing: start up after:

.1 Pressure tests have been completed.

.2 Disinfection procedures have been completed.

.3 Certificate of static completion has been issued.

.4 Water treatment systems operational.

.2 Provide continuous supervision during start-up.

.3 Start-up procedures:

.1 Establish circulation and ensure that air is eliminated.

.2 Check pressurization to ensure proper operation and to prevent water hammer, flashing, and/or cavitation.

.3 Bring HWS storage tank up to design temperature slowly.

.4 Monitor piping HWS and HWC piping systems for freedom of movement, pipe expansion as designed.

.5 Check control, limit, safety devices for normal and safe operation.

.4 Rectify start-up deficiencies.

3.7 PERFORMANCE VERIFICATION

.1 Scheduling:

.1 Verify system performance after pressure and leakage tests and disinfection are completed, and Certificate of Completion has been issued by Authority Having Jurisdiction.

.2 Procedures:

.1 Verify that flow rate and pressure meet Design Criteria.

.2 TAB HWC in accordance with Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.3 Adjust pressure regulating valves while withdrawal is maximum and inlet pressure is minimum.

.4 Sterilize HWS and HWC systems for Legionella control.

.5 Verify performance of temperature controls.

.6 Verify compliance with safety and health requirements.

.7 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or re-charge air chambers. Repeat for outlets and flush valves.

.8 Confirm water quality consistent with supply standards, and ensure no residuals remain as result of flushing or cleaning.

.3 Reports:

.1 In accordance with Section 01 91 13 - General Commissioning Requirements: Reports, using report forms as specified in Section 01 91 13 - General Commissioning Requirements: Report Forms and Schematics.

.2 Include certificate of water flow and pressure tests conducted on incoming water service, demonstrating adequacy of flow and pressure.

3.8 OPERATION REQUIREMENTS

.1 Coordinate operation and maintenance requirements including cleaning and maintenance of specified materials and products with Section 23 05 15 - Common Installation Requirements for HVAC Pipework.

3.9 CLEANING

.1 Clean in accordance with Section 01 74 00 - Cleaning.

.2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 ASTM International (ASTM):

.1 ASTM D2235- 04, Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.

.2 ASTM D2564- 04e1, Standard Specification for Solvent Cements for Poly (Vinyl-Chloride) (PVC) Plastic Piping Systems.

.2 CSA Group (CSA):

.1 CAN/CSA-Series B1800- 06, Thermoplastic Nonpressure Pipe Compendium - B1800 Series.

.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS):

.1 Safety Data Sheets (SDS).

.4 National Research Council Canada (NRC):

.1 National Plumbing Code of Canada 2020 (NPC).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Provide manufacturer's printed product literature and datasheets for piping and adhesives, and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Provide two copies WHMIS SDS - Safety Data Sheets.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle in accordance with Section 01 61 00 - Material & Equipment.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Store at temperatures and conditions recommended by manufacturer.

.4 Packaging Waste Management: remove for reuse and return of all packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 PIPING AND FITTINGS

.1 Sanitary piping less than 3" (75 mm) inside the building can be copper or PVC.

2.2 JOINTS

.1 Solvent weld for PVC: to ASTM D2564.

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

.1 In accordance with Section 23 05 15 - Common Installation Requirements for HVAC Pipework.

.2 Install in accordance with the National Plumbing Code and manufacturer's recommendations.

3.3 TESTING

.1 Hydraulically test to verify grades and freedom from obstructions.

3.4 PERFORMANCE VERIFICATION

.1 Cleanouts:

.1 Ensure accessible and that access doors are correctly located.

.2 Open, cover with linseed oil, and re-seal.

.3 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:

.1 Verify domes are secure.

.2 Ensure weirs are correctly sized and installed correctly.

.3 Verify provisions for movement of roof system.

.4 Ensure fixtures are properly anchored, connected to system and effectively vented.

.5 Affix applicable label (storm, sanitary, vent, pump discharge) c/w directional arrows every floor or 4.5 m (whichever is less).

3.5 CLEANING

.1 Clean in accordance with Section 01 74 00 - Cleaning:

.1 Remove surplus materials, excess materials, rubbish, tools, and equipment.

.2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 CSA Group (CSA):

.1 CSA B51:19, Boiler, Pressure Vessel, and Pressure Piping Code.

.2 CSA C22.2 No. 110-19, Construction and Test of Electric Storage Tank Water Heaters.

.3 CAN/CSA-C191-04, Performance of Electric Storage Tank Water Heaters for Domestic Hot Water Service.

.4 CSA C309:M90, Performance Requirements for Glass-Lined Storage Tanks for Household Hot Water Service.

.2 National Research Council Canada (NRC):

.1 National Plumbing Code of Canada 2020 (NPC).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for domestic water heater, and include product characteristics, performance criteria, physical size, finish, and limitations.

.3 Shop Drawings:

.1 Provide manufacturer's printed product literature and datasheets for domestic water heater, and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Indicate:

.1 Equipment, including connections, fittings, control assemblies, and ancillaries, identifying factory and site assembled.

1.3 CLOSEOUT SUBMITTALS

.1 Provide maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle in accordance with Section 01 61 00 - Material & Equipment.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Packaging Waste Management: remove for reuse and return of all packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 ELECTRIC TANK WATER HEATER

.1 Tanks shall be listed by Underwriters' Laboratories and approved to the NSF Standard 5 by UL. Tanks shall have 150 psi working pressure and be equipped with extruded high density anode. All internal surfaces of the heater(s) exposed to water shall be glass lined with an alkaline borosilicate composition that has been fused-to-steel by firing at a temperature range of 1400 °F to 1600 °F. Electric heating elements shall be low watt density. Each element shall be controlled by an individually mounted thermostat and high temperature cut-off switch. All internal circuits shall be fused. The outer jacket shall be of baked enamel finish and shall be provided with full size control compartment for performance of service and maintenance through hinged front panel and shall enclose the tank with foam insulation. Electrical junction box with heavy duty terminal block shall be provided. The drain valve shall be located in the front for ease of servicing. Heater tank shall have a three year limited warranty as outlined in the written warranty. Manufacturer shall supply ASME rated temperature and pressure relief valve. Fully illustrated instruction manual to be included. Meets standby loss requirements of NRCan and current edition of ASHRAE/IES 90.1.

2.2 THERMAL EXPANSION TANK FOR DOMESTIC HOT WATER

.1 Carbon steel expansion tank of welded construction, stainless steel connection, heavy duty butyl diaphragm, rigid polypropylene liner, NSF-61 listed for potable water systems.

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

.1 Install in accordance with manufacturer's recommendations and Authority Having Jurisdiction.

.2 Provide insulation between tank and supports.

3.3 SITE QUALITY CONTROL

.1 Manufacturer's factory trained, certified Engineer to start up and commission DHW heaters.

.2 Refer to Section 01 91 13 - General Commissioning Requirements for commissioning requirements.

3.4 CLEANING

.1 Clean in accordance with Section 01 74 00 - Cleaning:

.1 Remove surplus materials, excess materials, rubbish, tools, and equipment.

.2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Submit manufacturer's instructions, printed product literature, and data sheets for all Division 23 products and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Indicate on drawings:

.1 Mounting arrangements.

.2 Operating and maintenance clearances.

.3 Shop drawings and product data accompanied by:

.1 Detailed drawings of bases, supports, and anchor bolts.

.2 Acoustical sound power data, where applicable.

.3 Points of operation on performance curves.

.4 Manufacturer to certify current model production.

.5 Certification of compliance to applicable codes.

1.2 CLOSEOUT SUBMITTALS

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

.2 Operation and Maintenance Data: submit operation and maintenance data for all Division 23 products for incorporation into manual.

.1 Operation and maintenance manual approved by, and final copies deposited with, HRCE Representative before final inspection.

.2 Operation data to include:

.1 Control schematics for systems including environmental controls.

.2 Description of systems and their controls.

.3 Description of operation of systems at various loads together with reset schedules and seasonal variances.

.4 Operation instruction for systems and component.

.5 Description of actions to be taken in event of equipment failure.

.6 Valves schedule and flow diagram.

.7 Colour coding chart.

.3 Maintenance data to include:

.1 Servicing, maintenance, operation, and trouble-shooting instructions for each item of equipment.

.2 Data to include schedules of tasks, frequency, tools required, and task time.

.4 Performance data to include:

.1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.

.2 Equipment performance verification test results.

.3 Special performance data as specified.

.4 Testing, adjusting, and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.5 Approvals:

.1 Submit 2 copies of draft Operation and Maintenance Manual to HRCE Representative for approval. Submission of individual data will not be accepted unless directed by HRCE Representative.

.2 Make changes as required and re-submit as directed by HRCE Representative.

.6 Additional data:

.1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.

.7 Site records:

.1 HRCE Representative will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.

.2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.

.3 Use different colour waterproof ink for each service.

.4 Make available for reference purposes and inspection.

.8 As-built drawings:

.1 Prior to start of testing, adjusting, and balancing for HVAC, finalize production of as-built drawings.

.2 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)".

.3 Submit to HRCE Representative for approval and make corrections as directed.

.4 Perform testing, adjusting, and balancing for HVAC using as-built drawings.

.5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.

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

1.3 MAINTENANCE MATERIAL SUBMITTALS

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

.2 Furnish spare parts as follows:

.1 One set of packing for each pump.

.2 One casing joint gasket for each size pump.

.3 One head gasket set for each heat exchanger.

.4 One glass for each gauge glass.

.5 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.

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

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for all Division 23 product installation in accordance with manufacturer's written instructions:

.1 Visually inspect substrate in presence of HRCE Representative.

.2 Inform HRCE Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from HRCE Representative.

3.2 PAINTING REPAIRS AND RESTORATION

.1 Prime and touch up marred finished paintwork to match original.

.2 Restore to new condition, finishes which have been damaged.

3.3 SYSTEM CLEANING

.1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.

3.4 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

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

3.5 DEMONSTRATION

.1 Supply tools, equipment, and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting, and servicing of all systems and equipment during regular work hours, prior to acceptance.

.2 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.

3.6 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.

3.7 PROTECTION

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

END OF SECTION

Part 1 General

1.1 DEFINITIONS

.1 Demolish: Detach items from existing construction and legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.

.2 Remove: Planned deconstruction and disassembly of electrical items from existing construction including removal of conduit, junction boxes, cabling, and wiring from electrical component to panel taking care not to damage adjacent assemblies designated to remain; legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.

.3 Remove and Salvage: Detach items from existing construction and deliver them to HRCE Representative ready for reuse.

.4 Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.

.5 Existing to Remain: Existing items of construction that are not removed and that are not otherwise indicated as being removed and salvaged, or removed and reinstalled.

.6 Hazardous Substances: Dangerous substances, dangerous goods, hazardous commodities, and hazardous products may include asbestos, mercury and lead, PCB's, poisons, corrosive agents, flammable substances, radioactive substances, or other material that can endanger human health or wellbeing or environment if handled improperly as defined by the Federal Hazardous Products Act (RSC 1985) including latest amendments.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Action Submittals: Provide the following in accordance with Section 01 33 00 - Submittal Procedures before starting work of this Section:

.1 Construction Waste Management Plan (CWM Plan): Submit plan addressing opportunities for reduction, reuse, or recycling of materials prepared in accordance with Section 01 74 19 - Waste Management and Disposal.

.2 Landfill Records: Indicate receipt and acceptance of selective demolition waste and hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.3 ADMINISTRATIVE REQUIREMENTS

.1 Coordination: Coordinate work of this Section to avoid interference with work by other Sections.

1.4 QUALITY ASSURANCE

.1 Regulatory Requirements: Perform work of this Section in accordance with the following:

.1 Government of Canada, Labour Program: Workplace Safety.

.2 Provincial/Territorial Occupational Health and Safety Standards and Programs.

.3 Provincial/Territorial Worker's Compensation Boards/Commissions.

1.5 SITE CONDITIONS

.1 Existing Conditions: Condition of materials identified as being salvaged or demolished are based on their observed condition on date that tender is accepted.

1.6 SALVAGE AND DEBRIS MATERIALS

.1 Demolished items become Contractors property and will be removed from Project site; except for items indicated as being reused, salvaged, or otherwise indicated to remain HRCE's property.

.2 Carefully remove materials and items designated for salvage and store in a manner to prevent damage or devaluation of materials.

Part 2 Products

2.1 MATERIAL

.1 HVAC Repair Materials: Use only new materials required for completion or repair matching materials damaged during performance of work of this Section; new materials are required to meet assembly or system characteristics as existing systems indicated to remain and carry CSA approval labels required by the Authority Having Jurisdiction.

.2 Fire stopping Repair Materials: Use fire stopping materials compatible with existing fire stopping systems where removal or demolition work affects rated assemblies, restore to match existing fire rated performance.

Part 3 Execution

3.1 EXAMINATION

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

3.2 PREPARATION

.1 Protection of Existing Systems to Remain: Protect systems and components indicated to remain in place during selective demolition operations and as follows:

.1 Prevent movement and install bracing to prevent settlement or damage of adjacent services and parts of existing buildings scheduled to remain.

.2 Notify HRCE Representative and cease operations where safety of buildings being demolished, adjacent structures or services appears to be endangered and await additional instructions before resuming demolition work specified in this Section.

.3 Prevent debris from blocking drainage inlets.

.4 Protect mechanical systems that must remain in operation.

.2 Protection of Building Occupants: Sequence demolition work so that interference with the use of the building by the HRCE Representative and users is minimized and as follows:

.1 Prevent debris from endangering the safe access to and egress from occupied buildings.

.2 Notify HRCE Representative and cease operations where safety of occupants appears to be endangered and await additional instructions before resuming demolition work specified in this Section.

3.3 EXECUTION

.1 Demolition: Coordinate requirements of this Section with information as follows:

.1 Disconnect and cap gas supply and electrical services in accordance with requirements of local Authority Having Jurisdiction.

.2 Do not disrupt active or energized utilities without approval of the HRCE Representative.

.3 Erect and maintain dust proof and weather tight partitions to prevent the spread of dust and fumes to occupied building areas; remove partitions when complete.

.4 Demolish parts of existing building to accommodate new construction and remedial work as indicated.

.5 At end of each day's work, leave worksite in safe condition.

.6 Perform demolition work in a neat and workmanlike manner:

.1 Remove any tools or equipment after completion of work, and leave site clean and ready for subsequent renovation work.

.2 Repair and restore damages caused as a result of work of this Section to match existing materials and finishes.

3.4 CLOSEOUT ACTIVITIES

.1 Demolition Waste Disposal: Arrange for legal disposal and remove demolished materials to accredited Provincial landfill site or alternative disposal site (recycle centre) except where explicitly noted otherwise for materials being salvaged for reuse in new construction.

.2 Hazardous Substances Disposal: Arrange for disposal of hazardous substances in accordance with requirements of HRCE Representative.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 Canadian General Standards Board (CGSB):

.1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.

.2 CSA Group (CSA):

.1 CAN/CSA B139-19, Installation Code for Oil Burning Equipment.

.3 National Research Council Canada (NRC):

.1 National Fire Code of Canada 2020 (NFC).

1.2 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 MATERIAL

.1 Paint: zinc-rich to CAN/CGSB-1.181:

.1 Primers, Coatings, and Paints: in accordance with manufacturer's recommendations for surface conditions.

.2 Sealants: in accordance with Section 07 92 00 - Joint Sealants.

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 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 flexible connections, hoses, or other approved fittings when equipment mounted on vibration isolation and when piping subject to movement.

3.3 CLEARANCES

.1 Provide clearance around systems, equipment, and components for observation of operation, inspection, servicing, and maintenance and as recommended by manufacturer and applicable codes and standards.

.2 Provide space for disassembly and removal of equipment and components as recommended by manufacturer and/or as indicated without interrupting operation of other system, equipment, and components.

3.4 DRAINS

.1 Install piping with grade in direction of flow except as indicated.

.2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.

.3 Pipe each drain valve discharge separately to above floor drain:

.1 Discharge to be visible.

.4 Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap, and chain.

3.5 AIR VENTS

.1 Install air vents at high points in piping systems and as required by equipment manufacturer.

.2 Install isolating valve at each automatic air valve.

3.6 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.

3.7 PIPEWORK INSTALLATION

.1 Install pipework to requirements of applicable codes and standards.

.2 Screwed fittings jointed with Teflon tape.

.3 Protect openings against entry of foreign material.

.4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.

.5 Assemble piping using fittings manufactured to ANSI standards.

.6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main:

.1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.

.7 Install exposed piping, equipment, rectangular cleanouts, and similar items parallel or perpendicular to building lines.

.8 Install concealed pipework to minimize furring space, maximize headroom, conserve space.

.9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.

.10 Install, except where indicated, to permit separate thermal insulation of each pipe.

.11 Group piping wherever possible and as indicated.

.12 Ream pipes, remove scale, and other foreign material before assembly.

.13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.

.14 Provide for thermal expansion as indicated.

.15 Valves:

.1 Install in accessible locations.

.2 Remove interior parts before soldering.

.3 Install with stems above horizontal position unless indicated.

.4 Valves accessible for maintenance without removing adjacent piping.

.5 Use valves at branch take-offs for isolating purposes except where specified.

.6 Use chain operators on valves NPS 2 1/2 and larger where installed more than 2,400 mm above floor in Mechanical Rooms.

3.8 SLEEVES

.1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.

.2 Material: schedule 40 black steel pipe.

.3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.

.4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.

.5 Installation:

.1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.

.2 Other floors: terminate 25 mm above finished floor.

.3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.

.6 Sealing:

.1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.

.2 Elsewhere:

.1 Provide space for fire stopping.

.2 Maintain the fire-resistance rating integrity of the fire separation.

.3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.

.4 Ensure no contact between copper pipe or tube and sleeve.

3.9 ESCUTCHEONS

.1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.

.2 Construction: one piece type with set screws:

.1 Chrome or nickel plated brass or type 302 stainless steel.

.3 Sizes: outside diameter to cover opening or sleeve:

.1 Inside diameter to fit around pipe or outside of insulation if so provided.

3.10 PREPARATION FOR FIRE STOPPING

.1 Coordinate the installation of fire stopping around pipes, insulation, and adjacent fire separation.

.2 Pipes subject to movement: conform to fire stop system design listing to ensure pipe movement without damaging fire stopping material or installation.

.3 Insulated pipes: ensure integrity of insulation and vapour barriers.

3.11 FLUSHING OUT OF PIPING SYSTEMS

.1 Flush system in accordance with Section 23 08 16 - Cleaning and Start-up of HVAC Piping Systems.

.2 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 00 - Cleaning supplemented as specified in relevant mechanical sections.

.3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.12 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

.1 Advise 48 hours minimum prior to performance of pressure tests.

.2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.

.3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.

.4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.

.5 Conduct tests in presence of HRCE Representative.

.6 Pay costs for repairs or replacement, retesting, and making good. HRCE Representative to determine whether repair or replacement is appropriate.

.7 Insulate or conceal work only after approval and certification of tests by HRCE Representative.

3.13 EXISTING SYSTEMS

.1 Connect into existing piping systems at times approved by HRCE Representative.

.2 Request written approval by HRCE Representative 5 days minimum, prior to commencement of work.

.3 Be responsible for damage to existing plant by this work.

3.14 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.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME):

.1 ASME B40.100-2022, Pressure Gauges and Gauge Attachments.

.2 ASME B40.200-2008(R2013), Thermometers, Direct Reading and Remote Reading.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Submit manufacturer's instructions, printed product literature, and data sheets for thermometers and pressure gauges, and include product characteristics, performance criteria, physical size, finish, and limitations.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment, and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 GENERAL

.1 Design point to be at mid-point of scale or range.

.2 Ranges: as indicated.

2.2 DIRECT READING THERMOMETERS

.1 Industrial, variable angle type, mercury-free, liquid-filled, 125 mm scale length: to ASME B40.200:

.1 Resistance to shock and vibration.

2.3 REMOTE READING THERMOMETERS

.1 100 mm diameter activated dial type: to ASME B40.200, accuracy within one scale division, brass movement, stainless steel capillary, stainless steel spiral armour, stainless steel bulb, and polished stainless steel case for wall mounting.

2.4 THERMOMETER WELLS

.1 Copper pipe: copper or bronze.

.2 Steel pipe: stainless steel.

2.5 PRESSURE GAUGES

.1 112 mm, dial type: to ASME B40.100, Grade 2A, stainless steel bourdon tube having 0.5% accuracy full scale unless otherwise specified.

.2 Provide:

.1 Snubber for pulsating operation.

.2 Diaphragm assembly for corrosive service.

.3 Gasketted pressure relief back with solid front.

.4 Bronze stop cock.

.5 Oil filled for high vibration applications.

Part 3 Execution

3.1 GENERAL

.1 Install thermometers and gauges so they can be easily read from floor or platform:

.1 If this cannot be accomplished, install remote reading units.

.2 Install between equipment and first fitting or valve.

3.2 THERMOMETERS

.1 Install in wells on piping. Include heat conductive material inside well.

.2 Install in locations as indicated and on inlet and outlet of:

.1 Heat exchangers.

.2 Water heating and cooling coils.

.3 Water boilers.

.4 DHW tanks.

.3 Use extensions where thermometers are installed through insulation.

3.3 PRESSURE GAUGES

.1 Install in locations as follows:

.1 Suction and discharge of pumps.

.2 Upstream and downstream of PRV's.

.3 Upstream and downstream of control valves.

.4 Inlet and outlet of coils.

.5 Inlet and outlet of liquid side of heat exchangers.

.6 Outlet of boilers.

.7 In other locations as indicated.

.2 Install gauge cocks for isolation purposes, elsewhere as indicated.

.3 Use extensions where pressure gauges are installed through insulation.

3.4 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment in accordance with Section 01 74 00 - Cleaning.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME):

.1 ANSI/ASME B1.20.1-2013 (R2018), Pipe Threads, General Purpose (Inch).

.2 ASTM International (ASTM):

.1 ASTM B62-17, Standard Specification for Composition Bronze or Ounce Metal Castings.

.2 ASTM B505/B505M-22, Standard Specification for Copper-Base Alloy Continuous Castings.

.3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):

.1 MSS-SP-80-2019, Bronze Gate Globe, Angle and Check Valves.

.2 MSS-SP-110-2010, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Provide manufacturer's printed product literature and data sheets for valves specified in this Section and include product characteristics, performance criteria, physical size, finish, and limitations.

1.3 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials/Spare Parts:

.1 Furnish following spare parts:

.1 Valve seats: one for every 10 valves each size. Minimum 1.

.2 Discs: one for every 10 valves, each size. Minimum 1.

.3 Stem packing: one for every 10 valves, each size. Minimum 1.

.4 Valve handles: 2 of each size.

.5 Gaskets for flanges: one for every 10 flanged joints.

.2 Tools:

.1 Furnish special tools for maintenance of systems and equipment.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment, and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

.1 Valves:

.1 Except for specialty valves, to be single manufacturer.

.2 Products to have CRN registration numbers.

.2 End Connections:

.1 Connection into adjacent piping/tubing:

.1 Screwed ends with hexagonal shoulders to ANSI/ASME B1.20.1.

.3 Gate Valves:

.1 Requirements common to gate valves, unless specified otherwise:

.1 Standard specification: MSS SP-80.

.2 Bonnet: union with hexagonal shoulders.

.3 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.

.4 Packing: non-asbestos.

.5 Handwheel: non-ferrous.

.6 Handwheel Nut: bronze to ASTM B62.

.2 NPS 2 and under, non-rising stem, solid wedge disc, Class 125:

.1 Body: with long disc guides, screwed bonnet with stem retaining nut.

.2 Operator: Handwheel.

.3 NPS 2 and under, rising stem, split wedge disc, Class 125:

.1 Body: with long disc guides, screwed bonnet.

.2 Disc: split wedge, bronze to ASTM B283, loosely secured to stem.

.3 Operator: handwheel.

.4 Globe Valves:

.1 Requirements common to globe valves, unless specified otherwise:

.1 Standard specification: MSS SP-80.

.2 Bonnet: union with hexagonal shoulders.

.3 Pressure testing: to MSS SP-80. Tests to be hydrostatic.

.4 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.

.5 Handwheel: non-ferrous.

.6 Handwheel Nut: bronze to ASTM B62.

.2 NPS 2 and under, plug disc, Class 150, screwed ends:

.1 Disc and seat ring: tapered plug type with disc stem ring of AISI S420 stainless steel to ASTM A276, loosely secured to stem.

.2 Operator: handwheel.

.5 Check Valves:

.1 Requirements common to check valves, unless specified otherwise:

.1 Standard specification: MSS SP-80.

.2 NPS 2 and under, swing type, bronze disc, Class 125:

.1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.

.2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.

.6 Ball Valves:

.1 Standard specification: MSS SP-110.

.2 NPS 2 and under:

.1 Body and cap: cast high tensile bronze to ASTM B62.

.2 Pressure rating: Class 125.

.3 Stem: tamperproof ball drive.

.4 Stem packing nut: external to body.

.5 Ball and seat: replaceable stainless steel solid ball and Teflon seats.

.6 Stem seal: TFE with external packing nut.

.7 Operator: removable lockable lever handle.

.7 Pressure Independent Balancing and Control Valves:

.1 NPS 1/2 to NPS 2:

.1 Body: DeZincification Resistant (DZR) copper brass alloy.

.2 Differential Pressure Insert: DZR and polyphenylsulphide (PPS).

.3 Disc: stainless steel or DZR/PTFE.

.4 Stem and Spring: stainless steel.

.5 Seals and Membrane: EPDM.

.6 Pressure Rating: 1,600 kPa (230 psi).

.7 Operating Temperature Range: -10 °C to +90 °C.

.2 Performance:

.1 Max Flowrate: factory pre-set to flowrate as indicated.

.2 Flow Factor (Kv): manufacturer specified to suit installation requirements.

.3 Flow Characteristic: equal percentage.

.4 Min-Max Differential Pressure: 30 - 400 kPa (4.4 - 58 psi).

.3 Control:

.1 Modulating or 2 Position: as indicated.

.2 Actuator: 24 V electric.

.3 Control I/O: as indicated.

.4 Failure position: as indicated.

.5 Torque: manufacturer specified to suit installation requirements.

.6 Indication: visual scale or dial to indicate valve position.

.7 Factory installed and calibrated by valve manufacturer.

.8 Coil Kits:

.1 Size: NPS 1/2 to NPS 2.

.2 Construction: as specified this section or DZR copper brass alloy with EPDM seals and o-rings.

.3 Coil Inlet (Supply) Assembly:

.1 Combination Ball Valve/Strainer: DZR copper brass alloy, stainless steel ball, EPDM seals, 0.84 mm (20 mesh) stainless steel screen, 6 mm manual air vent, 6 mm drain ball valve with 19 mm hose thread and cap, 6 mm probe port with cap, FNPT inlet, FNPT union outlet.

.2 Hose: braided stainless steel flex hose with swivel connection at coil.

.4 Coil Outlet (Return) Assembly:

.1 Hose: braided stainless steel flex hose with swivel connection at coil.

.2 Pressure Independent Balancing and Control Valve: as specified this section.

.3 Combination Ball Valve: DZR copper brass alloy, stainless steel ball, EPDM seals, 6 mm drain ball valve with 19 mm hose thread and cap, 6 mm probe port with cap, FNPT union inlet, FNPT outlet.

.5 Handle and probe extensions where installed in insulated piping.

.6 Factory assembled and tagged to match equipment identification.

Part 3 Execution

3.1 INSTALLATION

.1 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.

3.2 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.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME):

.1 ASME B16.1-20, Cast Iron Pipe Flanges and Flanged Fittings.

.2 ASTM International (ASTM):

.1 ASTM A49-12 (2019), Standard Specification for Heat-Treated Carbon Steel Joint Bars.

.2 ASTM A126-04 (2019), Standard Specification for Grey Iron Castings for Valves, Flanges, and Pipe Fittings.

.3 ASTM A536-84 (2019) e1, Standard Specification for Ductile Iron Castings.

.4 ASTM B61-15 (2021), Standard Specification for Steam or Valve Bronze Castings.

.5 ASTM B62-17, Standard Specification for Composition Bronze or Ounce Metal Castings.

.6 ASTM B85/B85M-18e01, Standard Specification for Aluminum-Alloy Die Castings.

.3 CSA Group (CSA):

.1 CSA B242-05 (2015), Groove and Shoulder Type Mechanical Pipe Couplings.

.4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):

.1 MSS SP-61-2019, Pressure Testing of Steel Valves.

.2 MSS SP-70-2011, Grey Iron Gate Valves, Flanged and Threaded Ends.

.3 MSS SP-71-2018, Grey Iron Swing Check Valves, Flanged and Threaded Ends.

.4 MSS SP-82-1992, Valve Pressure Testing Methods.

.5 MSS SP-85-2011, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Provide manufacturer's printed product literature, specifications, and datasheets for valves and include product characteristics, performance criteria, physical size, finish, and limitations.

1.3 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials/Spare Parts:

.1 Furnish following spare parts:

.1 Valve seats: one for every 10 valves each size. Minimum 1.

.2 Discs: one for every 10 valves, each size. Minimum 1.

.3 Stem packing: one for every 10 valves, each size. Minimum 1.

.4 Valve handles: 2 of each size.

.5 Gaskets for flanges: one for every 10 flanged joints.

.2 Tools:

.1 Furnish special tools for maintenance of systems and equipment.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 MATERIAL

.1 Valves:

.1 Except for specialty valves, to be of single manufacturer.

.2 Standard specifications:

.1 Gate valves: MSS SP-70.

.2 Globe valves: MSS SP-85.

.3 Check valves: MSS SP-71.

.3 Requirements common to valves, unless specified otherwise:

.1 Body, bonnet: cast iron to ASTM B126 Class B or ductile iron to ASTM A536 Grade 65-45-12.

.2 Connections: flanged ends with 2 mm raised face with serrated finish to ANSI B16.1 or grooved ends to CSA B242.

.3 Inspection and pressure testing: to MSS SP-82.

.4 Bonnet gasket: non-asbestos.

.5 Stem: to have precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.

.6 Stuffing box: non-galling two-piece ball-jointed packing gland, gland bolts and nuts.

.7 Gland packing: non-asbestos.

.8 Handwheel: die-cast aluminum alloy to ASTM B85/B85M or malleable iron to ASTM A49. Nut of bronze to ASTM B62.

.9 Identification tag: with catalogue number, size, other pertinent data.

.4 All products to have CRN registration numbers.

2.2 GATE VALVES

.1 NPS 2 1/2 - 8, non rising stem, inside screw, bronze trim, solid wedge disc:

.1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, Class 125.

.2 Disc: solid offset taper wedge, bronze to ASTM B62.

.3 Seat rings: renewable bronze to ASTM B62, screwed into body.

.4 Stem: bronze to ASTM B62.

.5 Disc: solid offset taper wedge, cast iron to ASTM A126 Class B, secured to wrought steel stem.

.6 Seat: integral with body.

.7 Stem: wrought steel.

.8 Operator: handwheel.

.2 NPS 2 1/2-8, outside screw and yoke (OS&Y), bronze trim, solid wedge disc:

.1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full-length disc guides designed to ensure correct re-assembly, yoke, yoke hub, yoke sleeve, and nut. Class 125.

.2 Disc: solid offset taper wedge, bronze to ASTM B62 up to NPS 3, cast iron with bronze disc rings on other sizes, secured to stem through integral forged T-head disc-stem connection.

.3 Seat rings: renewable bronze screwed into body.

.4 Stem: manganese-bronze.

.5 Disc: solid offset taper all-cast iron, secured to stem through integral forged T-head disc-stem connection.

.6 Seat rings: integral with body.

.7 Stem: nickel-plated steel.

.8 Pressure-lubricated operating mechanism.

.9 Operator: handwheel.

2.3 GLOBE VALVES

.1 NPS 2 1/2 - 10, OSY:

.1 Body: with multiple-bolted bonnet.

.2 WP: 860 kPa steam, 1.4 MPa CWP.

.3 Bonnet-yoke gasket: non-asbestos.

.4 Disc: bronze to ASTM B62, fully guided from bottom, securely yet freely connected to stem for swivel action and accurate engagement with disc.

.5 Seat ring: renewable, regrindable, and screwed into body.

.6 Stem: bronze to ASTM B62.

.7 Operator: handwheel.

2.4 BYPASSES FOR GATE AND GLOBE VALVES

.1 Locations: on valves as indicated.

.2 Size of bypass valve:

.1 Main valve up to NPS 8: NPS 3/4.

.2 Main valve NPS 10 and over: NPS 1.

.3 Type of bypass valves:

.1 On gate valve: globe, with stainless steel disc, bronze trim, to Section 23 05 23.01 - Valves - Bronze. Pressure rating to match main valve.

2.5 VALVE OPERATORS

.1 Install valve operators as follows:

.1 Handwheel: on valves except as specified.

.2 Handwheel with chain operators: on valves installed more than 2,400 mm above floor in mechanical equipment rooms.

2.6 CHECK VALVES

.1 Swing check valves, Class 125:

.1 Body and bolted cover: with tapped and plugged opening on each side for hinge pin. Grooved or flanged ends: plain faced with smooth finish:

.1 Up to NPS 16: cast iron to ASTM A126 Class B or ductile iron ASTM A536 Grade 65-45-12.

.2 Ratings:

.1 NPS 2 1/2 - 12: 860 kPa steam; 1.4 MPa CWP.

.3 Disc: rotating for extended life:

.1 Up to NPS 6: bronze to ASTM B62.

.4 Seat rings: renewable bronze to ASTM B62 screwed into body.

.5 Hinge pin, bushings: renewable bronze to ASTM B62.

.6 Disc: A126 Class B, secured to stem, rotating for extended life.

.7 Seat: cast iron, integral with body.

.8 Hinge pin: exelloy; bushings: malleable iron.

.9 Identification tag: fastened to cover.

.10 Hinge: galvanized malleable iron.

Part 3 Execution

3.1 INSTALLATION

.1 Install rising stem valves in upright position with stem above horizontal.

3.2 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.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME):

.1 ASME B16.1-20, Grey Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

.2 ANSI/ASME B16.5-20, Pipe Flanges and Flanged Fittings: NPS ½ through 24.

.2 ASTM International (ASTM):

.1 ASTM A536-84 (2019)e1, Standard Specification for Ductile Iron Castings.

.3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):

.1 MSS SP-67-22, Butterfly Valves.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Provide manufacturer's printed product literature and data sheets for valves specified in this Section and include product characteristics, performance criteria, physical size, finish, and limitations.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment, and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

1.4 MAINTENANCE MATERIAL SUBMITTALS

.1 Furnish following spare parts:

.1 Valve seats: one for every 10 valves each size, minimum 1.

.2 Discs: one for every 10 valves, each size, minimum 1.

.3 Stem packing: one for every 10 valves, each size, minimum 1.

.4 Valve handles: 2 of each size.

.5 Gaskets for flanges: one for every 10 flanged joints.

.2 Tools:

.1 Furnish special tools for maintenance of systems and equipment.

Part 2 Products

2.1 BUTTERFLY VALVES - COMMON REQUIREMENTS

.1 Bubble tight shutoff with downstream flanges removed, suitable for dead-end service.

.2 CRN required for products.

.3 Designed to comply with MSS SP-67.

.4 Application: on-off operation.

2.2 BUTTERFLY VALVES - GROOVED CONNECTION

.1 Manufacturer: Victaulic.

.2 Sizes:

.1 Grooved end type: NPS 2-1/2 to 12.

.3 Pressure rating: 300 psig at 110 °C.

.4 Operators:

.1 NPS 2-1/2 - 6: handles capable of locking in any of ten (10) positions - 0 degrees to 90 degrees. Handle and release trigger - ductile iron. Return spring and hinge pin: carbon steel. Latch plate and mounting hardware: cadmium plated carbon steel.

.5 Construction:

.1 Body: ductile iron.

.2 Disc: plated ductile iron.

.3 Seat: EPDM.

.4 Shaft: 416 stainless steel.

.5 Disc shall not be pinned to shaft.

.6 Refer to manufacturer's literature for additional materials.

2.3 MOUNTING FLANGES

.1 Class 125 cast iron to ANSI B16.1 or Class 150 steel to B16.5 pipe flanges.

2.4 ELECTRIC ACTUATORS

.1 Operation: designed to provide precise quarter turn electric operation:

.1 Torque range: up to 1.130 N-m and speed ranges from 10 seconds to 30 seconds to move from fully open to fully closed.

.2 Gear train within actuator to provide smooth continuous rotary power stroke for accurate automatic valve positioning. Factory-set, field adjustable cam-actuated travel limit switches to provide precise control of shaft rotation.

.2 Construction:

.1 Castings: heavy duty industrial grade for rugged use.

.2 Actuators: continuous duty with high efficiency single phase reversing capacitor motor with thermal overload protection.

.3 Gears and pinions constructed from hardened steel.

.4 Gear train to be permanently lubricated.

.5 Mechanical brake to ensure that gear is locked in precise position.

.3 Electrical:

.1 Standard voltage: 120 VAC. 60 Hz.

.2 Control options: 2 position.

.3 CSA approved.

.4 Electrical rating: NEMA IV.

Part 3 Execution

3.1 PREPARATION

.1 Valve and mating flange preparation:

.1 Inspect adjacent pipeline, remove rust, scale, welding slag, and other foreign material.

.2 Ensure that valve seats and pipe flange faces are free of dirt or surface irregularities which may disrupt flange seating and cause external leakage.

.3 Install butterfly valves with disc in almost closed position.

.4 Inspect valve disc seating surfaces and waterway and eliminate dirt or foreign material.

3.2 INSTALLATION OF VALVES

.1 Install in accordance with manufacturer's instructions.

.2 Do not use gaskets between pipe flanges and valves unless instructed otherwise by valve manufacturer.

.3 Verify suitability of valve for application by inspection of identification tag.

.4 Mount actuator on to valve prior to installation.

.5 Handle valve with care so as to prevent damage to disc and seat faces.

.6 Valves in horizontal pipe lines should be installed with stem in horizontal position to minimize liner and seal wear.

.7 Ensure that valves are centered between bolts before bolts are tightened and then opened and closed to ensure unobstructed disc movement. If interference occurs due, for example to pipe wall thickness, taper bore adjacent piping to remove interference.

3.3 ACTUATOR INSTALLATION

.1 Cycle valve operation from fully closed to fully open then back to fully closed.

.2 At same time, check travel stop settings for proper disc alignment.

3.4 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment in accordance with Section 01 74 00 - Cleaning.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME):

.1 ASME B31.1-22, Power Piping.

.2 ASTM International (ASTM):

.1 ASTM A307-21, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.2 ASTM A563/A563M-21ae1, Standard Specification for Carbon and Alloy Steel Nuts (Inch and Metric).

.3 American National Standards Institute (ANSI)/Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS):

.1 MSS SP58-2018, Pipe Hangers And Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

.4 National Research Council Canada (NRC):

.1 National Plumbing Code of Canada 2020 (NPC).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment, and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 SYSTEM DESCRIPTION

.1 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 SP58.

.3 Ensure that supports, guides, and anchors do not transmit excessive quantities of heat to building structure.

.4 Design hangers and supports to support systems under 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 in accordance with MSS SP58.

2.2 GENERAL

.1 Fabricate hangers, supports, and sway braces in accordance with MSS SP58 and ANSI B31.1.

.2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

2.3 PIPE HANGERS

.1 Finishes:

.1 Pipe hangers and supports: galvanized after manufacture.

.2 Use electro-plating galvanizing process.

.3 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:

.1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.

.2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts, and washers.

.3 Upper attachment structural: suspension from upper flange of I-Beam:

.1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.

.2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer, and nut.

.4 Upper attachment to concrete:

.1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.

.2 Concrete inserts: wedge shaped body with knockout protector plate to MSS SP58

.5 Shop and field-fabricated assemblies:

.1 Trapeze hanger assemblies: as indicated.

.2 Steel brackets: as indicated.

.6 Hanger rods: threaded rod material to MSS SP58:

.1 Ensure that hanger rods are subject to tensile loading only.

.2 Provide linkages where lateral or axial movement of pipework is anticipated.

.3 Do not use 22 mm or 28 mm rod.

.7 Pipe attachments: material to MSS SP58:

.1 Attachments for steel piping: carbon steel galvanized.

.2 Attachments for copper piping: copper plated black steel.

.3 Use insulation shields for hot pipework.

.4 Oversize pipe hangers and supports.

.8 Adjustable clevis: material to MSS SP58, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis:

.1 Ensure "U" has hole in bottom for rivetting to insulation shields.

.9 Yoke style pipe roll: carbon steel yoke, rod, and nuts with cast iron roll, to MSS SP58.

.10 U-bolts: carbon steel to MSS SP58 with 2 nuts at each end to ASTM A563:

.1 Finishes for steel pipework: galvanized.

.2 Finishes for copper, glass, brass, or aluminum pipework: epoxy coated.

.11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP58.

2.4 INSULATION PROTECTION SHIELDS

.1 Insulated hot piping:

.1 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 SP58.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Install in accordance with:

.1 Manufacturer's instructions and recommendations.

.2 Clevis plates:

.1 Attach to concrete with 4 minimum concrete inserts, one at each corner.

.3 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

3.3 HANGER SPACING

.1 Gas and fuel oil piping: up to NPS 1: every 1.8 m.

.2 Copper piping: up to NPS 1: every 1.5 m.

.3 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.

.4 Within 300 mm of each elbow.

.5 Support Spacing: Conform to following table:

Maximum Pipe Size: NPS	Maximum Spacing Steel	Maximum Spacing Copper
Up to 1-1/4	2.4 m	1.8 m
1-1/2	3.0 m	2.4 m
2	3.0 m	2.4 m
2-1/2	3.7 m	3.0 m
3	3.7 m	3.0 m
3-1/2	3.7 m	3.3 m
4	3.7 m	3.6 m
5	4.3 m	
6	4.3 m	
8	4.3 m	
10	4.9 m	
12	4.9 m	

3.4 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.

3.5 HORIZONTAL MOVEMENT

.1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees 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.

3.6 FINAL ADJUSTMENT

.1 Adjust hangers and supports:

.1 Ensure that rod is vertical under operating conditions.

.2 Equalize loads.

.2 Adjustable clevis:

.1 Tighten hanger load nut securely to ensure proper hanger performance.

.2 Tighten upper nut after adjustment.

.3 C-clamps:

.1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.

.4 Beam clamps:

.1 Hammer jaw firmly against underside of beam.

3.7 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.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section includes:

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

1.2 REFERENCE STANDARDS

.1 CSA Group (CSA):

.1 CSA B149.1-20, Natural Gas and Propane Installation Code.

.2 Canadian General Standards Board (CGSB):

.1 CAN/CGSB-24.3-92, Identification of Piping Systems.

.3 National Fire Protection Association (NFPA):

.1 NFPA 13-2022, Standard for the Installation of Sprinkler Systems.

.2 NFPA 14-2019, Standard for the Installation of Standpipe and Hose Systems.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment, and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

.5 Paint and Coating Disposal:

.1 Dispose of unused paint and coating material at official hazardous material collections site.

.2 Do not dispose of unused paint and coating material into sewer system, into streams, lakes, onto ground, or in locations where it will pose health or environmental hazard.

Part 2 Products

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

.1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.

.2 Lettering and numbers raised or recessed.

.3 Information to include, as appropriate:

.1 Equipment: manufacturer's name, model, size, serial number, and capacity.

.2 Motor: voltage, Hz, phase, power factor, duty, and frame size.

2.2 SYSTEM NAMEPLATES

.1 Colours:

.1 Hazardous: red letters, white background.

.2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).

.2 Construction:

.1 3 mm thick laminated plastic, matte finish, with square corners, letters accurately aligned and machine engraved into core.

.3 Sizes:

.1 Conform to following table:

Size #	Sizes (mm)	No. of Lines	Height of Letters (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 100	2	5
6	20 x 200	1	8
7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20

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

.4 Locations:

.1 Terminal cabinets, control panels: use size #5.

.2 Equipment in Mechanical Rooms: use size #9.

.5 Identification for PSPC Preventive Maintenance Support System (PMSS):

.1 Use arrangement of Main identifier, Source identifier, Destination identifier.

.2 Equipment in Mechanical Room:

.1 Main identifier: size #9.

.2 Source and Destination identifiers: size #6.

.3 Terminal cabinets, control panels: size #5.

.3 Equipment elsewhere: sizes as appropriate.

2.3 PIPING SYSTEMS GOVERNED BY CODES

.1 Identification:

.1 Propane gas: to CSA/CGA B149.1.

2.4 IDENTIFICATION OF PIPING SYSTEMS

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

.2 Pictograms:

.1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.

.3 Legend:

.1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.

.4 Arrows showing direction of flow:

.1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.

.2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.

.3 Use double-headed arrows where flow is reversible.

.5 Extent of background colour marking:

.1 To full circumference of pipe or insulation.

.2 Length to accommodate pictogram, full length of legend, and arrows.

.6 Materials for background colour marking, legend, and arrows:

.1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.

.2 Other pipes: pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH, and continuous operating temperature of 150 °C and intermittent temperature of 200 °C.

.7 Colours and Legends:

.1 Where not listed, obtain direction from HRCE Representative.

.2 Colours for legends, arrows: to following table:

Background Colour	Legend and Arrows
Yellow	BLACK
Green	WHITE
Red	WHITE

.3 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
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID
Propane	To Codes	

2.5 IDENTIFICATION DUCTWORK SYSTEMS

.1 50 mm high stenciled letters and directional arrows 150 mm long x 50 mm high.

.2 Colours: black or co-ordinated with base colour to ensure strong contrast.

2.6 VALVES, CONTROLLERS

.1 Brass tags with 12 mm stamped identification data filled with black paint.

.2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, and location of tagged item.

2.7 CONTROLS COMPONENTS IDENTIFICATION

.1 Identify all systems, equipment, components, controls, and sensors with system nameplates specified in this section.

.2 Inscriptions to include function and (where appropriate) fail-safe position.

2.8 LANGUAGE

.1 Identification in English.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 TIMING

.1 Provide identification only after painting has been completed.

3.3 INSTALLATION

.1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.

.2 Provide ULC and/or CSA registration plates as required by respective agency.

3.4 NAMEPLATES

.1 Locations:

.1 In conspicuous location to facilitate easy reading and identification from operating floor.

.2 Standoffs:

.1 Provide for nameplates on hot and/or insulated surfaces.

.3 Protection:

.1 Do not paint, insulate, or cover.

3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

.1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, and tunnels: at not more than 17 m 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, confined spaces, at entry and exit points, and at access openings.

.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, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.

.9 Identification easily and accurately readable from usual operating areas and from access points:

.1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury, and reduced visibility over time due to dust and dirt.

3.6 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 Number valves in each system consecutively.

3.7 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.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 TAB is used throughout this Section to describe the process, methods, and requirements of testing, adjusting, and balancing for HVAC.

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

1.2 QUALIFICATIONS OF TAB PERSONNEL

.1 Submit names of personnel to perform TAB to HRCE Representative within 90 days of award of contract.

.2 Provide documentation confirming qualifications, successful experience.

.3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:

.1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, 7th Edition.

.2 National Environmental Balancing Bureau (NEBB), Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems, 9th Edition - 2019.

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing, 3rd Edition - 2002.

.4 Recommendations and suggested practices contained in the TAB Standard: mandatory.

.5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.

.6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.

.7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.

.8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract:

.1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.

.2 Where new procedures and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or SMACNA), requirements and recommendations contained in these procedures and requirements are mandatory.

1.3 PURPOSE OF TAB

.1 Test to verify proper and safe operation, determine actual point of performance, and evaluate qualitative and quantitative performance of equipment, systems, and controls at design, average, and low loads using actual or simulated loads.

.2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.

.3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.4 EXCEPTIONS

.1 TAB of systems and equipment regulated by codes and standards to satisfaction of Authority Having Jurisdiction.

1.5 CO-ORDINATION

.1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule 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.

1.6 PRE-TAB REVIEW

.1 Review Contract Documents before project construction is started confirm in writing to HRCE Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.

.2 Review specified standards and report to HRCE Representative in writing proposed procedures which vary from standard.

.3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports, and fittings.

1.7 START-UP

.1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.

.2 Follow special start-up procedures specified elsewhere in Division 23.

1.8 OPERATION OF SYSTEMS DURING TAB

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

1.9 START OF TAB

.1 Notify HRCE Representative days prior to start of TAB.

.2 Start TAB when building is essentially completed, including:

.1 Installation of ceilings, doors, windows, and other construction affecting TAB.

.2 Application of weatherstripping, sealing, and caulking.

.3 Pressure, leakage, and other tests specified elsewhere Division 23.

.4 Provisions for TAB installed and operational.

.3 Start-up and verification for proper, normal, and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:

.1 Proper thermal overload protection in place for electrical equipment.

.2 Air systems:

.1 Filters in place and clean.

.2 Duct systems clean.

.3 Ducts, air shafts, and ceiling plenums are airtight to within specified tolerances.

.4 Correct fan rotation.

.5 Fire, smoke, and volume control dampers installed and open.

.6 Coil fins combed and clean.

.7 Access doors installed and closed.

.8 Outlets installed and volume control dampers open.

.3 Liquid systems:

.1 Flushed, filled, and vented.

.2 Correct pump rotation.

.3 Strainers in place and baskets clean.

.4 Isolating and balancing valves installed, open.

.5 Calibrated balancing valves installed, at factory settings.

.6 Chemical treatment systems complete and operational.

1.10 APPLICATION TOLERANCES

.1 Do TAB to following tolerances of design values:

.1 HVAC systems: plus or minus 10%.

1.11 ACCURACY TOLERANCES

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

1.12 INSTRUMENTS

.1 Prior to TAB, submit to HRCE Representative list of instruments used together with serial numbers.

.2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.

.3 Calibrate within 3 months of TAB. Provide certificate of calibration to HRCE Representative.

1.13 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit, prior to commencement of TAB:

.1 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.14 TAB REPORT

.1 Format in accordance with referenced standard.

.2 TAB report to show results in SI units and to include:

.1 Project record drawings.

.2 System schematics.

.3 Submit TAB Report for verification and approval, in PDF format.

1.15 VERIFICATION

.1 Reported results subject to verification by HRCE Representative.

.2 Provide personnel and instrumentation to verify up to 30% of reported results.

.3 Number and location of verified results as directed by HRCE Representative.

.4 Pay costs to repeat TAB as required to satisfaction of HRCE Representative.

1.16 SETTINGS

.1 After TAB is completed to satisfaction of HRCE Representative, replace drive guards, close access doors, lock devices in set positions, and ensure sensors are at required settings.

.2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

1.17 COMPLETION OF TAB

.1 TAB considered complete when final TAB Report received and approved by HRCE Representative.

1.18 HVAC SYSTEMS

.1 Standard: TAB to most stringent of TAB standards of AABC, NEBB, or SMACNA.

.2 Do TAB of systems, equipment, components, and controls specified in Division 22, 23, and 25

.3 Qualifications: personnel performing TAB qualified to standards of AABC or NEBB.

.4 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC or NEBB.

.5 Measurements: to include as appropriate for systems, equipment, components, and controls:

.1 Air Systems: Air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, and noise.

.2 Liquid Systems: flow rate, pressure, pressure drop, and temperature.

.3 Motors: RPM, electrical power, voltage, noise, and vibration.

.6 Locations of equipment measurements: to include as appropriate:

.1 Air Systems: Inlet and outlet of dampers, filter, coil, humidifier, fan, or other equipment causing changes in conditions.

.2 Liquid Systems: Inlet and outlet of pumps, heat exchangers, boilers, chillers, separators, terminal devices, coils, and other equipment causing changes in conditions.

.3 At controllers, controlled device.

.7 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register, or diffuser).

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 DEFINITIONS

.1 For the purposes of this Section:

.1 Concealed means insulated mechanical services in suspended ceilings, or in non-accessible chases, or in furred-in spaces.

.2 Exposed means not concealed.

.3 Jacketing is synonymous with insulation cladding and lagging.

.4 Mineral fibre is synonymous with glass fibre, rock wool, or slag wool.

1.2 REFERENCE STANDARDS

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

.1 ANSI/ASHRAE/IES 90.1-2022, Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 ASTM International (ASTM):

.1 ASTM C335/C335M-23, Standard Test Method for Steady-State Heat Transfer Properties of Pipe Insulation.

.2 ASTM C449/C449M-07(2024), Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.

.3 ASTM C921-10(2015), Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.4 ASTM C1729-21, Standard Specification for Aluminum Jacketing for Insulation.

.3 Midwest Insulation Contractors Association (MICA):

.1 North American Commercial and Industrial Insulation Standards (NACIIS) Manual, 9th Edition.

.4 ULC Standards (ULC):

.1 CAN/ULC-S102-19 (R2024), Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC-S702.1-21, Standard for Mineral Fibre Thermal Insulation for Buildings, Part 1: Material Specification.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Submit a schedule with a list of insulation for each service location, insulation type, thickness, and jacketing type.

.2 Submit manufacturer's product literature, specifications, and datasheets. Include product characteristics, performance criteria, and limitations.

1.4 QUALITY ASSURANCE

.1 Qualifications:

.1 Installer: Specialist in performing work of this Section with at least three years successful experience in this type and size of project, member of Thermal Insulation Association of Canada (TIAC).

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment, and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address, and ULC markings.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 DESCRIPTION

.1 Regulatory Requirements:

.1 Combustible piping materials, including adhesives in accordance with CAN/ULC-S102:

.1 Flame-spread rating: Maximum 25.

.2 Smoke developed classification: Maximum 50.

2.2 INSULATION

.1 Thermal conductivity ("k" factor) not to exceed specified values at 24 °C mean temperature when tested in accordance with ASTM C335/C335M.

.2 Type A-1: Rigid moulded mineral fibre without factory-applied vapour retarder jacketing:

.1 Mineral fibre: To CAN/ULC-S702.1.

.2 Maximum "k" factor: To CAN/ULC-S702.1.

.3 Type A-3: Rigid moulded mineral fibre with factory-applied vapour retarder jacketing:

.1 Mineral fibre: To CAN/ULC-S702.1.

.2 Jacketing: To ASTM C921.

.3 Maximum "k" factor: To CAN/ULC-S702.1.

.4 Type A-6: Flexible unicellular tubular elastomer:

.1 Insulation: With vapour retarder jacket.

.2 Jacketing: To ASTM C921.

.3 Maximum "k" factor: 0.04 W/m·K.

.4 Certified by manufacturer as free of potential stress corrosion cracking corrosive substances.

2.3 JACKETING

.1 Polyvinyl Chloride (PVC) Jacketing:

.1 One-piece moulded type and sheet, in accordance with ASTM C921, with pre-formed shapes as required.

.2 Colours: As selected by HRCE Representative from manufacturer's standard colour range.

.3 Minimum service temperature: -20 °C.

.4 Maximum service temperature: 65 °C.

.5 Moisture vapour transmission: Maximum 0.02 perm.

.6 Thickness: 0.51 mm (20 mils).

.7 Fastenings:

.1 Use solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Tacks.

.3 Pressure sensitive vinyl tape in matching colour.

.8 Covering adhesive: Compatible with insulation.

2.4 ACCESSORIES

.1 Weatherproof Sealant for Jackets Installed Outdoors: In accordance with Section 07 92 00 - Joint Sealants.

.2 Tape: Self-adhesive, aluminum, reinforced, minimum 50 mm wide.

.3 Contact Adhesive: Quick setting type.

.4 Canvas Adhesive: Washable.

.5 Tie Wire: Stainless steel, minimum 1.5-mm diameter.

.6 Bands: Stainless steel, 19 mm wide, minimum 0.5 mm thick.

.7 Thermal Insulating and Finishing Cement: To ASTM C449, hydraulic setting type on mineral wool.

.8 Vapour Retarder Lap Adhesive: Water-based and fire retardant type, compatible with insulation.

.9 Indoor Vapour Retarder Finish: Vinyl emulsion type acrylic, compatible with insulation.

.10 Outdoor Vapour Retarder Finish:

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: Fibrous glass, untreated 305 g/m^2.

Part 3 Execution

3.1 PREPARATION

.1 Verify that pressure testing of piping systems and adjacent equipment is complete, witnessed, and certified.

.2 Verify that surfaces are clean, dry, and free from foreign material.

3.2 INSTALLATION

.1 Install to manufacturer's instructions and in accordance with MICA, North American Commercial and Industrial Insulation Standards (NACIIS) Manual.

.2 Provide two layers of insulation with staggered joints when required nominal wall thickness exceeds 75 mm.

.3 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.4 Install piping insulation continuous through wall and ceiling openings and sleeves, except where firestopping is required.

.5 Supports and Hangers:

.1 Hangers and supports in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

.2 Install hangars and supports outside vapour retarder jacket.

.3 Apply high compressive strength insulation that is suitable for HVAC piping service at oversized saddles and shoes where insulation saddles have not been provided.

3.3 INSTALLATION - ELASTOMERIC INSULATION

.1 Insulation to remain dry.

.2 Provide vapour retarder as recommended by manufacturer.

3.4 PIPING INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges, and fittings, unless otherwise specified.

.2 Type: A-1:

.1 Securements: Stainless steel wire at 300 mm on centre.

.2 Seals: Lap seal adhesive, lagging adhesive.

.3 Type: A-3:

.1 Securements: Stainless steel wire at 300 mm on centre.

.2 Seals: Vapour retarder lap seal adhesive, vapour retarder lagging adhesive.

.4 Type: A-6:

.1 Securements: to manufacturer's requirements.

.2 Seals: Lap seal adhesive, lagging adhesive.

.5 Provide insulation thickness as listed in the following table.

.1 Run-out: Branch piping to individual units and equipment not exceeding 4,000 mm long.

Application	Temperature	Piping Insulation Type	Run-out	Pipe sizes (NPS) to 1	Pipe sizes (NPS) 1 1/4 to 2	Pipe sizes (NPS) 2 1/2 to 4	Pipe sizes (NPS) 5 to 6	Pipe sizes (NPS) 8 & over
Hot Water Heating	60 - 94 °C	A-1	25 mm	38 mm	38 mm	38 mm	38 mm	38 mm
Hot Water Heating	Up to 59 °C	A-1	25 mm	25 mm	25 mm	25 mm	38 mm	38 mm
Glycol Heating	60 - 94 °C	A-1	25 mm	38 mm	38 mm	38 mm	38 mm	38 mm
Glycol Heating	Up to 59 °C	A-1	25 mm	25 mm	25 mm	25 mm	38 mm	38 mm
Refrigerant	4 - 13 °C	A-6	25 mm	25 mm	25 mm	25 mm	25 mm	25 mm
Refrigerant	Below 4 °C	A-6	25 mm	25 mm	38 mm	38 mm	38 mm	38 mm
Cooling Coil Condensate Drain		A-3	25 mm	25 mm	25 mm	25 mm	25 mm	25 mm

.6 Finishes:

.1 Exposed indoors: PVC jacketing.

.2 Exposed in mechanical rooms: PVC jacketing.

.3 Concealed, indoors: No additional finish.

.4 Outdoors: Waterproof aluminum jacketing.

.5 Outdoors: pipe insulation be completed with zero permeability insulation jacketing system.

.6 Finish attachments: Stainless steel bands, at 300 mm on centre.

.7 Seals: Wing.

3.5 SITE QUALITY CONTROL

.1 Non-Conforming Work: Replace insulation where there is damage to the vapour barrier and insulation is saturated with moisture.

3.6 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.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 ASTM International (ASTM):

.1 ASTM E202-18, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.2 HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)

.1 Perform hydronic systems performance verification after cleaning is completed and system is in full operation.

.2 When systems are operational, perform following tests:

.1 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.

.2 Verify performance of hydronic system circulating pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying:

.1 Pump operation.

.2 Boiler and/or chiller operation.

.3 Pressure bypass open/closed.

.4 Control pressure failure.

.5 Maximum heating demand.

.6 Maximum cooling demand.

.7 Boiler and/or chiller failure.

.8 Outdoor reset. Re-check heat exchanger output supply temperature at 100% and 50% reset, maximum water temperature.

1.3 HYDRONIC SYSTEM CAPACITY TEST

.1 Perform hydronic system capacity tests after:

.1 TAB has been completed

.2 Verification of operating, limit, and safety controls.

.3 Verification of primary and secondary pump flow rates.

.4 Verification of accuracy of temperature and pressure sensors and gauges.

.2 Calculate system capacity at test conditions.

.3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.

.4 When capacity test is completed, return controls and equipment status to normal operating conditions.

.5 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.

.6 Heating system capacity test:

.1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:

.1 Increasing OA flow rates through heating coils (in this case, monitor heating coil discharge temperatures to ensure that coils are not subjected to freezing conditions); or

.2 Reducing space temperature by turning of heating system for sufficient period of time before starting testing.

.2 Test procedures:

.1 Open fully heat exchanger, heating coil and radiation control valves.

.2 With boilers on full firing and hot water heating supply temperature stabilized, record flow rates and supply and return temperatures simultaneously.

.3 Conduct flue gas analysis test on boilers at full load and at low fire conditions.

1.4 GLYCOL SYSTEMS

.1 Test to prove concentration will prevent freezing to minus -30 °C Test inhibitor strength and include in procedural report. Refer to ASTM E202.

1.5 GASEOUS FUEL SYSTEMS

.1 Operation tests:

.1 Measure gas pressure at gas meter outlet and at burner manifold.

.2 Verify details of temperature and pressure compensation at meter.

.3 Verify settings, operation, venting of high and low pressure cut-outs, and alarms.

.4 Check terminals of vents for gas pressure regulators.

1.6 POTABLE WATER SYSTEMS

.1 When cleaning is completed and system filled:

.1 Verify performance of equipment and systems as specified elsewhere in Division 23.

.2 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or recharge air chambers. Repeat for each outlet and flush valve.

.3 Confirm water quality consistent with supply standards, verifying that no residuals remain resulting from flushing and/or cleaning.

1.7 REPORTS

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

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 ASTM International (ASTM):

.1 ASTM E202-18, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS):

.1 Safety Data Sheets (SDS).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Submit manufacturer's printed product literature, specifications, and datasheets. Include product characteristics, performance criteria, and limitations.

.2 Submit 2 copies of WHMIS SDS.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment, and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 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.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 CLEANING HYDRONIC SYSTEMS

.1 Timing: systems operational, hydrostatically tested and with safety devices functional before cleaning is carried out.

.2 Cleaning Agency:

.1 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:

.1 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 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 used to ensure water will not damage systems or equipment.

.5 Conditions at time of cleaning of systems:

.1 Systems: free from construction debris, dirt, and other foreign material.

.2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.

.3 Strainers: clean prior to initial fill.

.4 Install temporary filters on pumps not equipped with permanent filters.

.5 Install pressure gauges on strainers to detect plugging.

.6 Report on Completion of Cleaning:

.1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.

.7 Hydronic Systems:

.1 Fill system with water, ensure air is vented from system.

.2 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).

.3 Use water metre to record volume of water in system to +/- 0.5%.

.4 Add chemicals under direct supervision of chemical treatment supplier.

.5 Closed loop systems: circulate system cleaner at 60 °C for at least 36 hours. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.

.6 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.

.7 Add chemical solution to system.

.8 Establish circulation, raise temperature slowly to maximum design. Circulate for 12 hours, 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 hours 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).

.8 Glycol Systems:

.1 In addition to procedures specified above perform specified procedures.

.2 Test to prove concentration will prevent freezing to -25 °C. Test inhibitor strength and include in procedural report. Refer to ASTM E202.

3.3 START-UP OF HYDRONIC SYSTEMS

.1 After cleaning is completed and system is filled:

.1 Establish circulation and expansion tank level, set pressure controls.

.2 Ensure air is removed.

.3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.

.4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.

.5 Clean out strainers repeatedly until system is clean.

.6 Commission water treatment systems as specified in Section 23 25 00 - HVAC Water Treatment.

.7 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.

.8 Repeat with water at design temperature.

.9 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.

.10 Bring system up to design temperature and pressure slowly.

.11 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.12 Adjust pipe supports, hangers, and springs as necessary.

.13 Monitor pipe movement, performance of expansion joints, loops, guides, and anchors.

.14 If expansion joints flex incorrectly or bind, shut down system, re-align, and repeat start-up procedures.

.15 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.

.16 Check operation of drain valves.

.17 Adjust valve stem packings as systems settle down.

.18 Fully open balancing valves (except those that are factory-set).

.19 Check operation of over-temperature protection devices on circulating pumps.

.20 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

3.4 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment in accordance with Section 01 74 00 - Cleaning.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section includes:

.1 Materials and installation for piping, valves, and fittings for gas fired equipment.

1.2 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME):

.1 ASME B16.5-20, Pipe Flanges and Flanged Fittings.

.2 ASME B16.18-21, Cast Copper Alloy Solder Joint Pressure Fittings.

.3 ASME B16.22-21, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.

.4 ASME B18.2.1-12(2021), Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).

.2 ASTM International (ASTM):

.1 ASTM A47/A47M-99 (2022) e1, Standard Specification for Ferritic Malleable Iron Castings.

.2 ASTM A53/A53M-22, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.

.3 ASTM B837-19, Standard Specification for Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems.

.3 CSA Group (CSA):

.1 CSA W47.1-19, Certification of Companies for Fusion Welding of Steel.

.2 CSA B149.1-20, Natural Gas and Propane Installation Code.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Submit manufacturer's printed product literature, specifications, and datasheet for piping, valves, fittings, and equipment.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 PIPE

.1 Steel pipe: to ASTM A53/A53M, Schedule 40, seamless as follows:

.1 NPS 1/2 to 2, screwed.

.2 NPS2 1/2 and over, plain end.

.2 Copper tube: to ASTM B837.

2.2 JOINTING MATERIAL

.1 Screwed fittings: pulverized lead paste.

.2 Welded fittings: to CSA W47.1.

.3 Flange gaskets: nonmetallic flat.

.4 Brazing: to ASTM B837.

2.3 FITTINGS

.1 Steel pipe fittings, screwed, flanged, or welded:

.1 Malleable iron: screwed, banded, Class 150.

.2 Steel pipe flanges and flanged fittings: to ASME B16.5.

.3 Welding: butt-welding fittings.

.4 Unions: malleable iron, brass to iron, ground seat, to ASTM A47/A47M.

.5 Bolts and nuts: to ASME B18.2.1.

.6 Nipples: schedule 40, to ASTM A53/A53M.

.2 Copper pipe fittings, screwed, flanged, or soldered:

.1 Cast copper fittings: to ASME B16.18.

.2 Wrought copper fittings: to ASME B16.22.

2.4 VALVES

.1 Provincial Code approved, lubricated plug or ball type.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PIPING

.1 Install in accordance with Section 23 05 15 - Common Installation Requirements for HVAC Pipework, CAN/CSA B149.1, and applicable Provincial/Territorial Codes, supplemented as specified.

.2 Install drip points:

.1 At low points in piping system.

.2 At connections to equipment.

3.3 VALVES

.1 Install valves with stems upright or horizontal unless otherwise approved by HRCE Representative.

.2 Install valves at branch take-offs to isolate pieces of equipment, and as indicated.

3.4 FIELD QUALITY CONTROL

.1 Site Tests/Inspection:

.1 Test system in accordance with CAN/CSA B149.1 and requirements of Authorities Having Jurisdiction.

3.5 ADJUSTING

.1 Purging: purge after pressure test in accordance with CAN/CSA B149.1.

.2 Pre-Start-Up Inspections:

.1 Check vents from regulators, control valves, and terminate outside building in approved location, protected against blockage and damage.

.2 Check gas trains, entire installation is approved by Authority Having Jurisdiction.

3.6 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.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME):

.1 ASME B1.20.1-13 (2008), Pipe Threads, General Purpose, Inch.

.2 ASME B16.3-21, Malleable Iron Threaded Fittings: Classes 150 and 300.

.3 ASME B16.5-20, Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard.

.4 ASME B16.9-18, Factory-Made Wrought Buttwelding Fittings.

.5 ASME B18.2.1-12 (2021), Square Hex, Heavy Hex and Askew Head Bolts and Hex, Heavy Hex, Hex Flange. Loded Head and Lag Screws (Inch Series).

.6 ASME B18.2.2-22, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).

.2 ASTM International (ASTM):

.1 ASTM A53/A53M-22, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.

.2 ASTM A105/A105M-21, Standard Specification for Carbon Steel Forgings for Piping Applications.

.3 ASTM A197/A197M-00 (2019), Standard Specification for Cupola Malleable Iron.

.4 ASTM A234/A234M-23A, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.

.5 ASTM A536-84 (2019e1), Standard Specification for Ductile Iron Castings.

.6 ASTM E202-18, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.

.3 CSA Group (CSA):

.1 CSA B242-05 (R2021), Groove and Shoulder Type Mechanical Pipe Couplings.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Submit manufacturer's instructions, printed product literature, and data sheets for hydronic systems and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Include submittals for:

.1 Piping.

.2 Fittings.

.3 Flanges.

.4 Valves.

.3 Indicate on drawings:

.1 Selected options, components, and accessories.

1.3 EXTRA STOCK MATERIALS

.1 Supply spare parts as follows:

.1 Valve seats: 1 minimum for every ten valves, each size. Minimum one.

.2 Discs: 1 minimum for every ten valves, each size. Minimum one.

.3 Stem packing: 1 minimum for every ten valves, each size. Minimum one.

.4 Valve handles: 2 minimum of each size.

.5 Gaskets for flanges: 1 minimum for every ten flanges.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment, and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 PIPE

.1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:

.1 To NPS 10: Schedule 40.

2.2 PIPE JOINTS

.1 NPS 2 and under: screwed fittings to ASME B16.3 with lead-free pipe dope:

.1 Pipe thread: to ASME B1.20.1.

.2 NPS 2-1/2 and over: as indicated:

.1 Victaulic Roll grooved: standard or rigid couplings as indicated on drawings or as recommended by manufacturer. Couplings to CSA B242:

.1 Coupling gaskets: EPDM or as recommended by manufacturer to suit operating temperatures, pressures, and fluids.

.2 Welded: buttweld fittings to ASME B16.9 and flanges to ASME B16.5:

.1 Flanges: raised face, weld neck.

.2 Flange gaskets: suitable for operating temperatures, pressures, and fluids.

.3 Bolts and nuts: to ASME B18.2.1 and ASME B18.2.2.

2.3 FITTINGS

.1 Screwed fittings: malleable iron, to ASTM A197, Class 150.

.2 Fittings for Victaulic rool grooved piping: ductile iron to ASTM A536.

2.4 VALVES

.1 Connections: as indicated above. See Pipe Joints.

.2 Gate valves:

.1 NPS 2 and under:

.1 Mechanical Rooms: Class 125, rising stem, split wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.

.2 Elsewhere: Class 125, non- rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.

.2 NPS 2-1/2 and over:

.1 Mechanical Rooms: rising stem, split wedge disc, bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.

.2 Elsewhere: non- rising stem, solid wedge disc, bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.

.3 Butterfly valves:

.1 NPS 2-1/2 and over: as specified Section 23 05 23.05 - Butterfly Valves.

.4 Globe valves:

.1 NPS 2 and under: as specified in Section 23 05 23.01 - Valves - Bronze.

.2 NPS 2-1/2 and over: as specified in Section 23 05 23.02 - Valves - Cast Iron.

.5 Balancing valves, for TAB: As specified in Section 23 05 23.01 - Valves - Bronze.

.6 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.

.7 Swing check valves:

.1 NPS 2 and under: as specified in Section 23 05 23.01 - Valves - Bronze.

.2 NPS 2-1/2 and over: as specified in Section 23 05 23.02 - Valves - Cast Iron.

.8 Ball valves:

.1 NPS 2 and under: as specified Section 23 05 23.01 - Valves - Bronze.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hydronic systems installation in accordance with manufacturer's written instructions:

.1 Visually inspect substrate in presence of HRCE Representative.

.2 Inform HRCE Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from HRCE Representative.

3.2 PIPING INSTALLATION

.1 Install pipework in accordance with Section 23 05 15 - Common Installation Requirements for HVAC Pipework.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment in accordance with Section 01 74 00 - Cleaning.

3.4 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

Part 1 General

1.1 REFERENCE STANDARDS

.1 ASME:

.1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII-2023.

.2 ASTM International (ASTM):

.1 ASTM A126-04 (2019), Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

.2 ASTM A536-84 (2019) e1, Standard Specification for Ductile Iron Castings.

.3 ASTM B62-17, Standard Specification for Composition Bronze or Ounce Metal Castings.

.3 CSA Group (CSA):

.1 CSA B51-19, Boiler, Pressure Vessel, and Pressure Piping Code.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Submit manufacturer's instructions, printed product literature, and data sheets for hydronic piping specialties and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Include submittals for:

.1 Expansion tanks.

.2 Air vents.

.3 Air-Dirt-Magnetic Separators.

.4 Hydraulic Separators.

.5 Strainers.

.3 Indicate on drawings:

.1 Selected options, components, and accessories.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 BLADDER TYPE EXPANSION TANK

.1 Vertical steel pressurized bladder type expansion tank with 100% acceptance factor.

.2 Size and capacity: as indicated.

.3 Replaceable heavy duty butyl rubber bladder suitable for 115 °C operating temperature.

.4 Working pressure: 860 kPa with ASME stamp and certification.

.5 Air precharged to 84 kPa (initial fill pressure of system).

.6 Conform to: ASME BPVC, Section VII and CSA B51, and Provincial regulations.

2.2 AUTOMATIC AIR VENT

.1 Standard float vent: brass body and NPS 1/8 connection and rated at 690 kPa working pressure.

.2 Float: solid material suitable for 115 °C working temperature.

2.3 COMBINATION HYDRAULIC-AIR-DIRT-MAGNETIC SEPARATOR

.1 General:

.1 Fluid: Water or glycol solution to 50% concentration.

.2 Air: 100% removal down to micro-bubble level.

.3 Dirt: to 5 micron.

.4 Ferrous impurities: 100% removal, including magnetite, with removable neodymium rare-earth magnets.

.5 Pressure: 1,034 kPa, ASME rated.

.6 Temperature: 0 to 100 °C.

.7 Body: epoxy painted carbon steel.

.8 Air vent: automatic air vent, NPS 3/4 outlet connection, brass body, viton air seal, stainless steel air vent float, and with NPS 3/4 shut off ball valve for vent isolation/maintenance.

.9 Seals: EPDM.

.2 Size NPS 2½ to 4:

.1 ASME rated with CRN.

.2 Inlet/outlet connection: Class 150 raised face flange.

.3 Internal element: 300 series stainless steel screen and coalescing medium.

.4 Drain: NPS 1.

.5 Rigid closed cell expanded polyurethane foam shell insulation with external embossed aluminum cover.

2.4 COMBINATION AIR-DIRT-MAGNETIC SEPARATOR

.1 General:

.1 Air: 100% removal down to micro-bubble level.

.2 Dirt: to 5 micron.

.3 Ferrous impurities: 100% removal, including magnetite, with removable neodymium rare-earth magnets.

.4 Pressure: 1,034 kPa, ASME rated.

.5 Temperature: 0 to 110 °C.

.6 Body: epoxy painted carbon steel.

.7 Internal element: stainless steel screen and coalescing medium.

.8 Drain valve: brass with NPS 3/4 hose thread.

.9 Air vent: brass.

.10 Seals: EPDM.

.2 Size NPS 1-1/2 to 2:

.1 Inlet/outlet connections: Screwed female union.

.2 Drain: NPS 3/4 hose thread.

.3 Size NPS 2-1/2 to 6:

.1 Inlet/outlet connection: Class 150 raised face flange.

.2 Drain: NPS 1.

2.5 PIPE LINE STRAINER

.1 NPS 1/2 to 2: bronze body to ASTM B62, screwed connections, Y pattern.

.2 NPS 2 1/2 to 12: Y pattern, cast iron body to ASTM A126, Class 125 flanged connections.

.3 NPS 2 to 12: T type with ductile iron body to ASTM A536, grooved ends.

.4 Blowdown connection: NPS 1.

.5 Screen: stainless steel with 1.19 mm perforations.

.6 Working pressure: 860 kPa.

2.6 GLYCOL FEEDER

.1 Packaged, automatic glycol solution make up unit. The package shall consist of a base, propylene glycol 208 litre reservoir with removable lid compatible of up to 50% solutions, visible solution level scale in gallons and liters, y-strainer, isolation valve, pump, open drip-proof motor, pump isolation, check and balance valve, discharge pressure gauge, motor contactor and control circuit in a NEMA 4 panel, and necessary interconnecting piping.

.2 Green light shall indicate power supplied to unit. Pump shall start based on falling pressure. System shall require a 120/1/60 single power connection and a 19 mm NPT system piping connection. Glycol feeder shall provide 19 LPM and maintain a fill pressure of 207 kPa.

.3 Unit includes low level cut-out, with red indicator light and 110 V contact for alarm indication, to stop the pump during low level condition, remote monitoring dry contacts. Contractor shall furnish application specific pressure reducing valve between glycol feeder and connection to the system piping.

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and data sheets.

3.2 GENERAL

.1 Run drain lines and blow off connections to terminate above nearest drain.

.2 Maintain adequate clearance to permit service and maintenance.

.3 Should deviations beyond allowable clearances arise, request, and follow HRCE Representative directive.

.4 Check shop drawings for conformance of tappings for ancillaries and for equipment operating weights.

3.3 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 and as indicated.

3.4 AIR VENTS

.1 Install at high points of systems.

3.5 EXPANSION TANKS

.1 Adjust expansion tank pressure to suit design criteria.

3.6 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.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE):

.1 ANSI/ASHRAE/IES Standard 90.1-2022, Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 American Society of Mechanical Engineers (ASME):

.1 ASME B16.1-2020, Gray Iron Pipe Flanges And Flanged Fittings: Classes 25, 125, And 250.

.3 ASTM International (ASTM):

.1 ASTM A536-84 (2019e1), Standard Specification for Ductile Iron Castings.

.2 ASTM A582/582M-22, Standard Specification for Free-Machining Stainless Steel Bars.

.3 ASTM B584-22, Standard Specification for Copper Alloy Sand Castings for General Applications.

.4 CSA Group (CSA):

.1 CSA C22.2 No. 108-14 (2019), Liquid Pumps.

.5 International Organization for Standardization (ISO):

.1 ISO 21940-11-2016 (2021), Mechanical vibration - Rotor balancing - Part 11: Procedures and Tolerances for Rotors with Rigid Behaviour.

.6 Institute of Electrical and Electronics Engineers (IEEE):

.1 IEEE 519-2022, IEEE Standard for Harmonic Control in Electric Power Systems.

.7 National Electrical Manufacturers' Association (NEMA):

.1 ANSI/NEMA 250-2020, Enclosures For Electrical Equipment (1,000 Volts Maximum).

.8 Underwriters Laboratories (UL):

.1 UL 778-Edition 6, UL Standard for Motor-Operated Water Pumps.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Submit manufacturer's instructions, printed product literature, and data sheets for pump, circulator, and equipment, and include product characteristics, performance criteria, physical size, finish, and limitations indicate point of operation, and final location in field assembly.

.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.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 VARIABLE SPEED VERTICAL IN-LINE CIRCULATORS

.1 General:

.1 Design pump for variable flow applications and selected for hydraulic design conditions and minimum system pressure with sensorless load Demand Based and EMCS control.

.2 Select hydraulic design conditions and minimum pressure with sensorless load control.

.3 Meet or exceed energy saving requirements of ASHRAE 90.1.

.4 Design pumping units to UL STD 778 & CSA STD C22.2 No. 108.

.2 Casing: Ductile iron ASTM A536, Epoxy coated:

.1 Test casing to 150% maximum working pressure.

.2 Ensure casing is radially split to allow for removal of rotating element without disturbing pipe connections.

.3 Casing wetted surfaces shall be epoxy-coated to prevent seizing of impeller to casing after periods of inactivity.

.4 Drill and tap casing for gauge ports on both suction and discharge connections.

.5 Drill and tap casing at lowest point for drain port.

.3 Impeller: To ASTM B584, bronze, fully enclosed and dynamically balanced to ISO 21940-11 G6.3 and fitted to shaft with key. Use two-plane balancing when installed impeller diameter is less than 6 times impeller width.

.4 Pump Shafts: Split-coupled, stainless steel to ASTM A582/A582M, Grade 416.

.5 Flanges: Class 125, to ANSI/ASME B16.1.

.6 Flush Line: 3/8 inch braided stainless steel complete with vent, factory installed. Ensure flush/vent line runs from seal chamber to pump suction.

.7 Casing Gasket: Synthetic fiber.

.8 Mechanical Seal: Fluid as indicated, Type 2A inside single spring seal design and rated to 121 °C:

.1 Rotating face: Silicon Carbide or Resin Bonded Carbon to suit fluid.

.2 Stationary face: Sintered Silicon Carbide.

.3 Seal rotating hardware: Stainless Steel.

.4 Secondary/shaft seal elastomer: EPDM.

.5 Maximum Total Dissolved Solids (TDS): 2,000 PPM.

.9 Motor:

.1 Permanent Magnet Motor, Variable Speed, TEFC enclosure, and as indicated on drawings.

.10 Controls:

.1 Integrated with motor. Type 12 minimum enclosure rating to NEMA 250, sensorless controls complete with fused disconnect switch and menu-driven graphical keypad interface.

.1 Orientation: To suit site conditions.

.2 Cooling: Fan cooled through back panel.

.3 Ambient working conditions: 45 °C, up to 1,000 m above sea level.

.4 Sensorless override for EMCS control signal.

.5 Manual pump control/Closed loop PID control.

.6 Communication protocol: BACnet.

.7 Communications ports: 1- RS485.

.8 Auto alarm reset

.2 Provide near unity displacement power factor (cos Ø) without need for external power factor correction capacitors at all loads and speeds using VVC-PWM type integrated controls:

.1 Incorporate DC link reactors for reduction of mains borne harmonic currents and DC link ripple current to increase DC link capacitor lifetime.

.2 Fit RFI filters as standard to ensure integrated controls meets low emission and immunity requirements.

.3 Ensure additional 3% AC line reactor is available for controls with saturating (nonlinear) DC link reactors.

.4 Harmonic suppression: Dual DC-link reactors (Equivalent: 5% impedance AC line reactor) to mitigate harmonics to support IEEE 519 system requirements.

.3 Input/Output:

.1 Analog I/O: 2 inputs minimum, 1 output minimum. Output can be configured for voltage or current.

.2 Digital I/O: 2 inputs minimum, 2 outputs minimum. Outputs can be configured as inputs.

.3 Pulse inputs: 2 programmable minimum.

.4 Relay outputs: 2 programmable minimum.

.5 One volt free contact.

.4 Minimum system pressure to be maintained: 40% of design head

.5 Software: Ensure software for sensorless control includes automatic speed control in variable volume systems without need for pump mounted (internal/external) or remotely mounted differential pressure sensor.

.1 Operating mode under sensorless control: Quadratic Pressure Control (QPC).

.2 Ensure head reduction with reducing flow conforms to quadratic control curve.

.3 Head at zero flow: 40% minimum of design duty head.

.4 Linear or Proportional Pressure Control without sensor is unacceptable.

.5 Ensure control mode setting and minimum/maximum head set points are user adjustable using built-in programming interface.

.6 performance for non-overloading power at every point of operation.

.7 Ensure integrated control software is capable of flow rate display and data output of ± 5% accuracy to EMCS.

.8 Ensure the controls can displayed and digitally transmit real-time flow and values.

.6 For multiple pump configuration ensure duty/standby is applied

.11 Pump motor and controls protection:

.1 Motor phase to phase fault.

.2 Motor phase to ground fault.

.3 Loss of supply phase.

.4 Over voltage.

.5 Under voltage.

.6 Motor over temperature.

.7 Inverter overload.

.8 Over current.

.9 Ensure controls run Automatic Motor Adaptation (AMA) for superior motor protection and control.

.12 Accessories:

.1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

.2 Suction Diffuser: grooved pipe or flanged Class 125, to ANSI/ASME B16.1 flange as indicated.

.3 Pressure Gauges: 114 mm diameter sized to meet system pressure requirements.

2.2 IN-LINE CIRCULATORS

.1 Volute: cast iron radially split, with screwed or flanged design suction and discharge connections.

.2 Impeller: copper alloy.

.3 Shaft: alloy steel with bronze sleeve bearing, integral thrust collar.

.4 Seal assembly: mechanical for service to 121 °C.

.5 Coupling: rigid self-aligning.

.6 Capacity: as indicated.

2.3 SUCTION DIFFUSER

.1 Body: cast iron with screwed or flanged connections.

.2 Strainer: with built-in, disposable 1.19 mm mesh, low pressure drop screen and NPS 1 blowdown connection.

.3 Full length straightening vanes.

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and data sheets.

3.2 INSTALLATION

.1 In line circulators: install as indicated by flow arrows:

.1 Support at inlet and outlet flanges or unions.

.2 Install with bearing lubrication points accessible.

.2 Ensure that pump body does not support piping or equipment:

.1 Provide stanchions or hangers for this purpose.

.2 Where pumps are supported entirely by piping system ensure hangers are sized for extra load of pump weight.

.3 Refer to manufacturer's installation instructions for details.

.3 Pipe drain tapping to floor drain.

.4 Install volute venting pet cock in accessible location.

.5 Check rotation prior to start-up. Do not dry run pump to check rotation.

.6 Install pressure gauges with test cocks on suction and discharge pump connections.

.7 Install suction diffuser on pump suction connection.

3.3 START-UP

.1 General:

.1 In accordance with manufacturer's recommendations.

.2 Procedures:

.1 Before starting pump, check that cooling water system over-temperature and other protective devices are installed and operative.

.2 After starting pump, check for proper and safe operation.

.3 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.

.4 Check base for free-floating, no obstructions under base.

.5 Run-in pumps for 12 continuous hours minimum.

.6 Verify operation of over-temperature and other protective devices under low- and no-flow condition.

.7 Eliminate air from scroll casing.

.8 Adjust water flow rate through water-cooled bearings.

.9 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.

.10 Adjust alignment of piping and conduit to ensure true flexibility.

.11 Eliminate cavitation, flashing, and air entrainment.

.12 Adjust pump shaft seals, stuffing boxes, and glands.

.13 Measure pressure drop across strainer when clean and with flow rates as finally set.

.14 Replace seals if pump used to degrease system or if pump used for temporary heat.

3.4 PERFORMANCE VERIFICATION (PV)

.1 General:

.1 Verify performance in accordance with Section 01 91 13 - General Commissioning Requirements: General Requirements, supplemented as specified herein.

.2 Verify that manufacturer's performance curves are accurate.

.3 Ensure valves on pump suction and discharge provide tight shut-off.

.4 Net Positive Suction Head (NPSH):

.1 Application: measure NPSH for pumps which operate on open systems and with water at elevated temperatures.

.2 Measure using procedures prescribed in Section 01 91 13 - General Commissioning Requirements.

.3 Where procedures do not exist, discontinue PV, report to HRCE Representative and await instructions.

.5 Multiple Pump Installations - Series and Parallel:

.1 Repeat PV procedures specified above for pump performance and pump BHP for 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 01 91 13 - General Commissioning Requirements reports supplemented as specified herein. Reports to include:

.1 Record of points of actual performance at maximum and minimum conditions and for single and parallel operation as finally set at completion of commissioning on pump curves.

.2 Use Report Forms specified in Section 01 91 13 - General Commissioning Requirements: Report Forms and Schematics.

.3 Pump performance curves (family of curves).

3.5 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment in accordance with Section 01 74 00 - Cleaning.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 ASME:

.1 ASME B16.22-21, Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.

.2 ASME B16.24-21, Cast Copper Pipe Flanges and Flanged Fittings: Class 150, 300, 600, 900, 1500 and 2500.

.3 ASME B16.26-18, Cast Copper Alloy Fittings for Flared Copper Tubes.

.4 ASME B31.5-22, Refrigeration Piping and Heat Transfer Components.

.2 ASTM International (ASTM):

.1 ASTM A307-21, Standard Specification for Carbon Steel Bolts and Studs, and Threaded Rod 60,000 PSI Tensile Strength.

.2 ASTM B280-20, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

.3 CSA Group (CSA):

.1 CSA B52-18, B52 Package, Mechanical Refrigeration Code.

.4 Environment Canada (EC):

.1 EPS 1/RA/1-15 (E2021), Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

.5 Government of Canada, Department of Justice (DOJ):

.1 Canadian Environmental Protection Act (CEPA), 1999:

.1 SOR/2022-110, Federal Halocarbon Regulations, 2022

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Submit manufacturer's instructions, printed product literature, and data sheets for refrigerant piping, fittings, and equipment, and include product characteristics, performance criteria, physical size, finish, and limitations.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment, and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 TUBING

.1 Processed for refrigeration installations, deoxidized, dehydrated, and sealed.

.1 Hard copper: to ASTM B280, type ACR.

.2 Annealed copper: to ASTM B280, with minimum wall thickness as per CSA B52 and ASME B31.5.

2.2 FITTINGS

.1 Service: design pressure 3,100 kPa and temperature 121 °C.

.2 Brazed:

.1 Fittings: wrought copper to ASME B16.22.

.2 Joints: silver solder, 15% Ag-80% Cu-5%P and non-corrosive flux.

.3 Flanged:

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

.2 Gaskets: suitable for service.

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

.4 Flared:

.1 Bronze or brass, for refrigeration, to ASME B16.26.

2.3 PIPE SLEEVES

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

2.4 VALVES

.1 22 mm and under: Class 500, 3.5 Mpa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moisture proof seal for below freezing applications, brazed connections.

.2 Over 22 mm: Class 375, 2.5 Mpa, globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and bonnet, moisture proof seal for below freezing applications, brazed connections.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 GENERAL

.1 Install in accordance with CSA B52, Federal Halocarbon Regulations, EPS1/RA/1, ASME B31.5, and Section 23 05 15 - Common Installation Requirements for HVAC Pipework.

3.3 BRAZING PROCEDURES

.1 Bleed inert gas into pipe during brazing.

.2 Remove valve internal parts, solenoid valve coils, sight glass.

.3 Do not apply heat near expansion valve and bulb.

3.4 PIPING INSTALLATION

.1 General:

.1 Soft annealed copper tubing: bend without crimping or constriction.

.2 Hard drawn copper tubing: do not bend. Minimize use of fittings.

3.5 PRESSURE AND LEAK TESTING

.1 Close valves on factory charged equipment and other equipment not designed for test pressures.

.2 Leak test to CSA B52 before evacuation to 2 MPa and 1 MPa on high and low sides respectively.

.3 Test procedure: build pressure up to 35 kPa with refrigerant gas on high and low sides. Supplement with nitrogen to required test pressure. Test for leaks with electronic or halide detector. Repair leaks and repeat tests.

3.6 FIELD QUALITY CONTROL

.1 Site Tests/Inspection:

.1 Close service valves on factory charged equipment.

.2 Ambient temperatures to be at least 13 °C for at least 12 hours before and during dehydration.

.3 Use copper lines of largest practical size to reduce evacuation time.

.4 Use two-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5 Pa absolute and filled with dehydrated oil.

.5 Measure system pressure with vacuum gauge. Take readings with valve between vacuum pump and system closed.

.6 Triple evacuate system components containing gases other than correct refrigerant or having lost holding charge as follows:

.1 Twice to 14 Pa absolute and hold for 4 hours.

.2 Break vacuum with refrigerant to 14 kPa.

.3 Final to 5 Pa absolute and hold for at least 12 hours.

.4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.

.5 Submit test results to HRCE Representative.

.7 Charging:

.1 Charge system through filter-drier and charging valve on high side. Low side charging not permitted.

.2 With compressors off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.

.3 Re-purge charging line if refrigerant container is changed during charging process.

.8 Checks:

.1 Make checks and measurements as per manufacturer's operation and maintenance instructions.

.2 Record and report measurements to HRCE Representative.

.9 Manufacturer's Field Services:

.1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection, and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.

.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

.3 Schedule site visits, to review Work, at stages listed:

.1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.

.2 Twice during progress of Work at 25% and 60% complete.

.3 Upon completion of the Work, after cleaning is carried out.

.4 Obtain reports, within 3 days of review, and submit, immediately, to HRCE Representative.

3.7 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.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 ASME:

.1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII-2023.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS):

.1 Safety Data Sheets (SDS).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Submit manufacturer's instructions, printed product literature, and data sheets for HVAC water treatment systems and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Submit 2 copies of WHMIS SDS.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 MANUFACTURER

.1 Equipment, chemicals, and service provided by one supplier.

2.2 POT FEEDER

.1 Welded steel, pressure rating 860 kPa. Temperature rating: 90 °C.

2.3 WATER TREATMENT FOR HYDRONIC SYSTEMS

.1 Hot water heating system: pot feeder, 19 L, operating pressure 860 kPa.

.2 Glycol system: pot feeder, 19 L, operating pressure 860 kPa.

.3 Micron filter for each pot feeder:

.1 Capacity 2% of pump recirculating rate at operating pressure.

.2 Six (6) sets of filter cartridges for each type, size of micron filter.

2.4 CHEMICALS

.1 Provide 1 years supply.

2.5 TEST EQUIPMENT

.1 Provide one set of test equipment for each system to verify performance.

.2 Complete with carrying case, reagents for chemicals, specialized, or supplementary equipment.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Install HVAC water treatment systems in accordance with ASME Boiler and Pressure Code Section VII, and requirements and standards of Authorities Having Jurisdiction, except where specified otherwise.

.2 Ensure adequate clearances to permit performance of servicing and maintenance of equipment.

3.3 CLEANING OF MECHANICAL SYSTEM

.1 Provide copy of recommended cleaning procedures and chemicals for approval by HRCE Representative.

.2 Flush mechanical systems and equipment with approved cleaning chemicals designed to remove deposition from construction such as pipe dope, oils, loose mill scale and other extraneous materials. Use chemicals to inhibit corrosion of various system materials that are safe to handle and use.

.3 Examine and clean filters and screens, periodically during circulation of cleaning solution, and monitor changes in pressure drop across equipment.

.4 Drain and flush systems until alkalinity of rinse water is equal to make-up water. Refill with clean water treated to prevent scale and corrosion during system operation.

.5 Disposal of cleaning solutions approved by Authority Having Jurisdiction.

3.4 WATER TREATMENT SERVICES

.1 Provide water treatment monitoring and consulting services for period of 1 year after system start-up. Service to include:

.1 Initial water analysis and treatment recommendations.

.2 System start-up assistance.

.3 Operating staff training.

.4 Visit plant every 7 days during period of operation and as required until system stabilizes, and advise on treatment system performance.

.5 Provide necessary recording charts and log sheets for 1 year operation.

.6 Provide necessary laboratory and technical assistance.

.7 Provide clear, concise, written instructions and advice to operating staff.

3.5 FIELD QUALITY CONTROL

.1 Start-up:

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

.2 Verify:

.1 Presence of test equipment, reagents, chemicals, details of specific tests performed, and operating instructions.

.2 Suitability of log book.

.3 Currency and accuracy of initial water analysis.

.4 Required quality of treated water.

.3 Procedures - Water Treatment Systems:

.1 Establish, adjust as necessary, and record automatic controls and chemical feed rates.

.2 Monitor performance continuously during commissioning of connected systems and until acceptance of project.

.3 Establish test intervals and regeneration intervals.

.4 Record on approved report forms commissioning procedures, test procedures, dates, times, quantities of chemicals added, raw water analysis, treated water analysis, test results, instrument readings, adjustments made, and results obtained.

.5 Establish, monitor, and adjust automatic controls and chemical feed rates as necessary.

.6 Visit project at specified intervals after commissioning is satisfactorily completed to verify that performance remains as set during commissioning (more often as required until system stabilizes at required level of performance).

.4 Procedures - Closed Circuit Hydronic Systems:

.1 Analyze water in system.

.2 Based upon an assumed rate of loss establish rate of chemical feed.

.3 Record types, quantities of chemicals applied.

3.6 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.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

.2 ASTM International (ASTM):

.1 ASTM A480/A480M-23, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.

.2 ASTM A653/A653M-22, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

.3 National Fire Protection Association (NFPA):

.1 NFPA 96-24, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

.4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):

.1 HVAC Duct Construction Standards - Metal and Flexible, 4th Edition, 2020.

.2 HVAC Air Duct Leakage Test Manual, 2nd Edition, 2012.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Submit manufacturer's instructions, printed product literature, and data sheets for metal ducts and include product characteristics, performance criteria, physical size, finish, and limitations.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment, and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 SEAL CLASSIFICATION

.1 Seal classification:

.1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.

2.2 SEALANT

.1 Sealant: oil-resistant, water-borne, polymer-type flame-resistant duct sealant. Temperature range of minus 30 °C to plus 93 °C.

2.3 TAPE

.1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.

2.4 DUCT LEAKAGE

.1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual.

2.5 FITTINGS

.1 Fabrication: to SMACNA.

.2 Radiused elbows:

.1 Rectangular: standard radius.

.2 Round: 5-piece, centreline radius: 1.5 times diameter.

.3 Mitred elbows, rectangular:

.1 To 407 mm: with single thickness turning vanes.

.2 Over 407 mm: with double thickness turning vanes.

.4 Branches:

.1 Rectangular main and branch: with 45 degrees entry on branch.

.2 Round main and branch: enter main duct at 45 degrees with conical connection.

.3 Provide volume control damper in branch duct near connection to main duct.

.4 Main duct branches: with splitter damper.

.5 Transitions:

.1 Diverging: 20 degrees maximum included angle.

.2 Converging: 30 degrees maximum included angle.

.6 Offsets:

.1 As indicated.

.7 Obstruction deflectors: maintain full cross-sectional area:

.1 Maximum included angles: as for transitions.

2.6 GALVANIZED STEEL

.1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.

.2 Thickness, fabrication and reinforcement: to SMACNA.

.3 Joints: to SMACNA. Proprietary manufactured flanged duct joint to be considered to be a class A seal.

2.7 HANGERS AND SUPPORTS

.1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment:

.1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct:

.1 Maximum size duct supported by strap hanger: 500.

.2 Hanger configuration: to SMACNA.

.3 Hangers: galvanized steel angle with galvanized steel rods to SMACNA.

.4 Upper hanger attachments:

.1 For concrete: manufactured concrete inserts.

.2 For steel joist: manufactured joist clamp.

.3 For steel beams: manufactured beam clamps:

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for metal duct installation in accordance with manufacturer's written instructions:

.1 Visually inspect substrate in presence of HRCE Representative.

.2 Inform HRCE Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from HRCE Representative.

3.2 GENERAL

.1 Do work in accordance with ASHRAE and SMACNA.

.2 Do not break continuity of insulation vapour barrier with hangers or rods.

.1 Insulate strap hangers 100 mm beyond insulated duct.

.3 Support risers in accordance with SMACNA.

.4 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.

.5 Manufacture duct in width/height and diameter to accommodate installation of acoustic duct lining. Dimensions indicated are clear inside.

3.3 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

3.4 WATERTIGHT DUCT

.1 Provide watertight duct for:

.1 Fresh air intake.

.2 Minimum 3,000 mm from duct mounted humidifier in all directions.

.3 As indicated.

.2 Form bottom of horizontal duct without longitudinal seams:

.1 Weld joints of bottom and side sheets.

.2 Seal other joints with duct sealer.

.3 Fit base of riser with 150 mm deep drain sump and 32 mm drain connected, with deep seal trap and discharging to funnel floor drain.

3.5 SEALING AND TAPING

.1 Apply sealant in accordance with SMACNA and to manufacturer's recommendations.

.2 Bed tape in sealant and recoat with minimum of 1 coat of sealant to manufacturers recommendations.

3.6 LEAKAGE TESTS

.1 In accordance with SMACNA HVAC Duct Leakage Test Manual.

.2 Do leakage tests in sections.

.3 Make trial leakage tests as instructed to demonstrate workmanship.

.4 Do not install additional ductwork until trial test has been passed.

.5 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degrees elbows.

.6 Complete test before performance insulation or concealment Work.

3.7 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.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):

.1 HVAC Duct Construction Standards - Metal and Flexible, 4th Edition, 2020.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Submit manufacturer's instructions, printed product literature, and data sheets for dampers and include product characteristics, performance criteria, physical size, finish, and limitations.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 GENERAL

.1 Manufacture to SMACNA standards.

2.2 SINGLE BLADE DAMPERS

.1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.

.2 Size and configuration to recommendations of SMACNA, except maximum height 200 mm for rectangular ducts.

.3 Locking quadrant with shaft extension to accommodate insulation thickness.

.4 Inside and outside nylon end bearings.

.5 Channel frame of same material as adjacent duct, complete with angle stop.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for damper installation in accordance with manufacturer's written instructions:

.1 Visually inspect substrate in presence of HRCE Representative.

.2 Inform HRCE Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from HRCE Representative.

3.2 INSTALLATION

.1 Install where indicated.

.2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.

.3 Locate balancing dampers in each branch duct, for supply, return, and exhaust systems.

.4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.

.5 Dampers: vibration free.

.6 Ensure damper operators are observable and accessible.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment in accordance with Section 01 74 00 - Cleaning.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Submit manufacturer's instructions, printed product literature, and data sheets for diffusers, registers, and grilles and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Indicate following:

.1 Capacity.

.2 Throw and terminal velocity.

.3 Noise criteria.

.4 Pressure drop.

.5 Neck velocity.

1.2 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials:

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

.2 Include:

.1 Keys for volume control adjustment.

.2 Keys for air flow pattern adjustment.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 GENERAL

.1 Grilles, registers, and diffusers of same generic type, products of one manufacturer.

.2 To meet capacity, pressure drop, terminal velocity, throw, noise level, and neck velocity as indicated:

.1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

.3 Refer to drawing schedules.

.4 Frames:

.1 Full perimeter gaskets.

.2 Plaster frames where set into plaster or gypsum board.

.3 Concealed fasteners.

.5 Volume control dampers: as indicated on drawing schedules.

.6 Colour: white.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for diffuser, register, and grille installation in accordance with manufacturer's written instructions:

.1 Visually inspect substrate in presence of HRCE Representative.

.2 Inform HRCE Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from HRCE Representative.

3.2 INSTALLATION

.1 Install in accordance with manufacturers instructions.

.2 Install with oval head screws in countersunk holes where fastenings are visible.

.3 Bolt grilles, registers, and diffusers, in place, in gymnasium and similar game rooms.

.4 Provide concealed safety chain on each grille, register, and diffuser in gymnasium and similar game rooms and elsewhere as indicated.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment in accordance with Section 01 74 00 - Cleaning.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 National Fire Protection Association (NFPA):

.1 NFPA 96-24, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

.2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

.3 Society of Automotive Engineers (SAE).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Submit manufacturer's instructions, printed product literature, and data sheets for louvers, intakes, and vents, and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Indicate following:

.1 Pressure drop.

.2 Face area.

.3 Free area.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 SYSTEM DESCRIPTION

.1 Performance Requirements:

.1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

2.2 FIXED LOUVRES - ALUMINUM

.1 Construction: welded with exposed joints ground flush and smooth.

.2 Material: extruded aluminum alloy 6063-T5.

.3 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1,500 mm.

.4 Frame, head, sill, and jamb: 100 mm deep one piece extruded aluminum, minimum 3 mm thick with approved caulking slot, integral to unit.

.5 Mullions: at 1,500 mm maximum centres.

.6 Fastenings: stainless steel SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.

.7 Screen: 12.7 mm mesh, 2 mm diameter wire aluminum birdscreen on inside face of louvres in formed U-frame.

.8 Finish: factory primed and baked enamel resin coating. Colour: to HRCE Representative approval.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for louvres, intakes, and vents installation in accordance with manufacturer's written instructions:

.1 Visually inspect substrate in presence of HRCE Representative.

.2 Inform HRCE Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from HRCE Representative.

3.2 INSTALLATION

.1 In accordance with manufacturer's and SMACNA recommendations.

.2 Reinforce and brace as indicated.

.3 Anchor securely into opening. Seal with caulking to ensure weather tightness.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment in accordance with Section 01 74 00 - Cleaning.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 American Boiler Manufacturers Association (ABMA).

.2 ASME:

.1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII-2023.

.3 CSA Group (CSA):

.1 CAN1-3.1-77 (R2016), Industrial and Commercial Gas-Fired Package Boilers.

.2 CSA B51-19, Boiler, Pressure Vessel, and Pressure Piping Code.

.3 CSA B149.1-20, Natural Gas and Propane Installation Code.

.4 ANSI Z21.13-22 /CSA 4.9-22, Gas-Fired Low-Pressure Steam and Hot Water Boilers.

.4 Electrical and Electronic Manufacturers Association of Canada (EEMAC).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Submit manufacturer's instructions, printed product literature, and data sheets for heating boilers and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Indicate on drawings:

.1 General arrangement showing terminal points and instrumentation test connections.

.2 Clearances for operation, maintenance, servicing, tube cleaning, and tube replacement.

.3 Foundations with loadings and anchor bolt arrangements.

.4 Piping hook-ups.

.5 Equipment electrical drawings.

.6 Burners and controls.

.7 All miscellaneous equipment.

.8 Flame safety control system.

.9 Breeching and stack configuration.

.10 Stack emission continuous monitoring system to measure CO, O, NOx, SO, stack temperature and smoke density of flue gases.

.3 Engineering data to include:

.1 Boiler efficiency at 25%, 50%, 75%, 100%, and 110% of design capacity.

.2 Radiant heat loss at 100% design capacity.

1.3 QUALITY ASSURANCE

.1 Regulatory Requirements: work to be performed in compliance with applicable Provincial/Territorial regulations.

1.4 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra materials:

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

.1 Special tools for burners, access opening, handholes and Operation and Maintenance.

.2 Spare parts for 1 year of operation.

.3 Spare gaskets.

.4 Spare gauge glass inserts.

.5 Probes and sealants for electronic indication.

.6 Spare burner tips.

.7 Spare burner gun.

.8 Safety valve test gauge.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment, and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 CONDENSING GAS FIRED BOILER

.1 General:

.1 Description: Boiler shall be natural gas fired, fully condensing, and fire tube design. The boiler shall be factory-fabricated, factory-assembled, and factory-tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.

.2 CRN (Canadian Registration Number) to CSA B51. Boiler/burner package to bear CSA label.

.3 Heat Exchanger: The heater exchanger shall bear the ASME “H” stamp for 160 psi working pressure and shall be National Board listed. The heat exchanger shall be constructed of a fully welded 316 L stainless steel and of fire tube design. The heat exchanger shall be designed for a single-pass water flow to limit the water side pressure drop. Cast iron, aluminum, or condensing copper tube boilers will not be accepted.

.4 Efficiency: Boilers shall have an AHRI certified minimum thermal efficiency of 97 percent.

.5 Condensate Collection Basin: Fully welded 316 L stainless steel and shall include a stainless steel combustion analyzer test port.

.6 Pressure Vessel: The pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The pressure vessel shall be designed for a single-pass water flow to limit the water side pressure drop. The pressure vessel shall contain a volume of water no less than 16 gallons.

.7 Burner: Natural gas, forced draft single burner premix design. The burner shall be high temperature stainless steel with a woven Fecralloy outer covering to provide modulating firing rates. The burner shall be capable of the stated gas train turndown without loss of combustion efficiency.

.8 Blower: Boiler shall be equipped with a pulse width modulating blower system to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The burner firing sequence of operation shall include pre-purge, firing, modulation, and post-purge operation.

.9 Gas Train: The boiler shall be supplied with a negative pressure regulation gas train and shall be capable of a minimum turndown of 7:1.

.10 Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

.11 Casing:

.1 Jacket: Heavy gauge primed and painted steel jacket with snap-in closures.

.2 Control Compartment Enclosures: NEMA 250, Type 1A.

.3 Insulation: Minimum 13 mm thick, mineral fiber insulation surrounding the heat exchanger.

.4 Combustion-Air Connections: Inlet and vent duct collars.

.2 Characteristics and Capacities:

.1 Performance: As indicated.

.2 Heating Medium: Hot water.

.3 Design Water Pressure Rating: 1,100 kPa working pressure.

.4 Safety Relief Valve Setting: 345 kPa.

.5 Minimum Water Flow Rate: 1.3 litres per second.

.6 Piping Arrangement: Primary Variable.

.3 Trim/Auxiliaries:

.1 Provide auxiliaries for each boiler and to meet CSA and ASME requirements.

.2 Safety Relief Valve:

.1 Size and Capacity: to relieve full boiler capacity.

.2 Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.

.3 Pressure Gauge: as indicated in Section 23 05 19.01 - Thermometers and Pressure Gauges - Piping Systems.

.4 Thermometer: as indicated in Section 23 05 19.01 - Thermometers and Pressure Gauges - Piping Systems.

.5 Flue gas temperature sensor: by Boiler Manufacturer.

.6 Drain Valves: Minimum NPS 3/4 or nozzle size with hose-end connection.

.7 Condensate Neutralization Kit: Factory supplied condensate trap with condensate trip sensor, high capacity condensate receiver prefilled with appropriate medium.

.4 Boiler venting:

.1 Boiler vent and combustion air shall be CPVC, installed to manufacturer's instructions.

.2 Exhaust:

.1 Condensate neutralizing kit to be installed on common exhaust vent low point drain at end opposite of stack tie-in.

.2 Boiler shall come standard with a flue sensor to monitor and display flue gas temperature on factory provided LCD display.

.3 Boiler exhaust pipe length must be able to extend to 108 equivalent feet (33.0 m).

.3 Intake piping must be approved by boiler manufacturer.

.1 CPVC Boiler intake piping must be able to extend to 100 equivalent feet (30.5 m).

.4 Boiler venting and intake piping configuration as indicated and approved by boiler manufacturer.

.5 Controls:

.1 Boiler controls shall feature a standard, factory installed multi-color graphic LCD screen display with navigation dial and includes the following standard features:

.1 Variable Speed Boiler Pump Control: Boiler may be programmed to send a 0 - 10 V DC output signal to an ECM or VFD boiler pump to maintain a designed temperature rise across the heat exchanger. The boiler shall be able to operate in this mode with a minimum temperature rise of 20 °F and a maximum temperature rise of 60 °F.

.2 Password Security: Boiler shall have a different password security code for the User and the Installer to access adjustable parameters.

.3 Outdoor air reset: Boiler shall calculate the set point using a field installed, factory supplied outdoor sensor and an adjustable reset curve.

.4 Pump exercise: Boiler shall energize any pump it controls for an adjustable time if the associated pump has been off for a time period of 24 hours.

.5 Ramp delay: Boiler may be programmed to limit the firing rate based on six limits steps and six time intervals.

.6 Time clock: Boiler shall have an internal time clock with the ability to time and date stamp lock-out codes and maintain records of runtime.

.7 Maintenance reminder: Boiler shall have the ability to display a yellow colored, customizable maintenance notification screen. All notifications are adjustable by the installer based upon months of installation, hours of operation, and number of boiler cycles.

.8 English Error codes: Boiler shall have a user interface that displays a red error screen with fault codes that are displayed in English and include a date and time stamp for ease of servicing.

.9 Anti-cycling control: Boiler shall have the ability to set a time delay after a heating demand is satisfied allowing the boiler to block a new call for heat. The boiler will display an anti-cycling blocking on the screen until the time has elapsed or the water temperature drops below the anti-cycling differential parameter. The anti-cycling control parameter is adjustable by the installer.

.10 Space Heating Night setback: Boiler may be programmed to reduce the space heating temperature set point during a certain time of the day.

.11 Freeze protection: Boiler shall turn on the boiler and system pumps when the boiler water temperature falls below 45 °F. When the boiler water temperature falls below 37 °F the boiler will automatically turn on. Boiler and pumps will turn off when the boiler water temperature rises above 43 °F.

.12 Isolation valve control: Boiler shall have the ability to control a 2-way motorized control valve. Boiler shall also be able to force a fixed number of valves to always be energized regardless of the number of boilers that are firing.

.13 EMCS integration with 0 - 10 V DC input: The Control shall allow an option to Enable and control set point temperature or control firing rate by sending the boiler a 0 - 10 V input signal.

.14 Data logging: Boiler shall have non-volatile data logging memory including last 10 lockouts, space heat run hours, domestic hot water run hours and ignition attempts. All data should be visible on the boiler screen.

.2 The boiler shall have a built in Cascade controller to sequence and rotate lead boiler to ensure equal runtime while maintaining modulation of up to 8 boilers of different BTU inputs without utilization of an external controller. The factory installed, internal cascade controller shall include:

.1 Lead lag: The Control module shall allow only one boiler to fire at the beginning of a call for heat. Once the lead boiler is in full fire and the control calculates that additional heat is required it will call on an additional boiler as needed.

.2 Efficiency optimization: The Control module shall allow multiple boilers to simultaneously fire at minimum firing rate in lieu of Lead/Lag.

.3 Rotation of lead boiler: The Control module shall change the lead boiler every hour for the first 24 hours after initializing the Cascade. Following that, the leader will be changed once every 24 hours.

.4 Boiler operating controls shall include the following devices and features:

.1 Set-Point Adjust: Set points shall be fully adjustable by the installer.

.2 Sequence of Operation: Factory installed controller to modulate burner firing rate to maintain system water temperature in response to call for heat.

.3 Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation and include:

.1 High Temperature Limit: Automatic and manual reset stops burner if operating conditions rise above maximum boiler design temperature. Limit switch to be manually reset on the control interface.

.2 Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manually reset on the control interface.

.3 Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.

.4 High and Low Gas Pressure Switches: Pressure switches shall prevent burner operation on low or high gas pressure. Pressure switches to be manually reset on the control interface.

.5 Blocked Drain Switch: Blocked drain switch shall prevent burner operation when tripped. Switch to be manually reset on the control interface.

.6 Low air pressure switch: Pressure switches shall prevent burner operation on low air pressure. Switch to be manually reset on the control interface.

.7 Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for any lockout conditions.

.4 EMCS Interface:

.1 Boiler shall have the ability to receive a 0 - 10 V system from a building management system and control by the following:

.1 0 - 10 V DC input to control Modulation or Setpoint.

.2 0 - 10 V DC input from Variable speed Boiler pump.

.3 0 - 10 V DC output signal to a Variable speed system pump.

.4 0 - 10 V DC input Enable/Disable signal.

.2 Factory installed BACnet gateway interface to enable building automation system to monitor, control, and display boiler status and alarms.

.6 Emissions:

.1 Rate of discharge of air contaminants from boiler not to exceed:

.1 For nitrogen oxides expressed as nitrogen dioxide: 22 ng/J of heat input.

.2 For carbon monoxide: 125 ng/J of heat input.

.7 Electrical:

.1 Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 25 and 26 Sections.

.2 Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

.3 Electrical Characteristics: 120 V/1 Ph/60 Hz, <12 A.

.4 Electrical components: CSA approved.

.8 Factory Testing:

.1 Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

.2 Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

2.2 AUXILIARIES

.1 Provide auxiliaries for each boiler and to meet ASME requirements.

.2 Hot water boilers:

.1 Relief valves: ASME rated, sized to release entire boiler capacity.

.2 Pressure gauge: 90 mm diameter complete with shut-off cock.

.3 Thermometer: 115 mm diameter range 10 to 150 °C.

.4 Low water cut-off: with visual and audible alarms.

.5 Auxiliary low water cut-off: with separate cold water connection to boiler.

.6 Isolating gate valves: on supply and return connections.

.7 Drain valve: NPS 2.

.8 Stack thermometer: range 65 to 400 °C.

.9 Outdoor controller: to reset operating temperature controller.

.10 1 set of cleaning tools.

.3 Pot type chemical feeder.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for heating boiler installation in accordance with manufacturer's written instructions:

.1 Visually inspect substrate in presence of HRCE Representative.

.2 Inform HRCE Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from HRCE Representative.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 INSTALLATION

.1 Install in accordance with ASME Boiler and Pressure Vessels Code, regulations of Authority Having Jurisdiction, except where specified otherwise, and manufacturers recommendations.

.2 Make required piping connections to inlets and outlets recommended by boiler manufacturer.

.3 Maintain clearances as indicated or if not indicated, as recommended by manufacturer for operation, servicing, and maintenance without disruption of operation of any other equipment/system.

.4 Mount unit level.

.5 Pipe hot water relief valves full size to nearest drain.

.6 Natural gas fired installations: in accordance with CSA B149.1.

3.4 MOUNTINGS AND ACCESSORIES

.1 Safety valves and relief valves:

.1 Run separate discharge from each valve.

.2 Terminate discharge pipe as indicated.

.3 Run drain pipe from each valve outlet and drip pan elbow to above nearest drain.

.2 Blowdown valves:

.1 Run discharge to terminate as indicated.

3.5 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment in accordance with Section 01 74 00 - Cleaning.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 Air-Conditioning, Heating, and Refrigeration Institute (AHRI):

.1 AHRI 1060-2018, Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment.

.2 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE):

.1 ASHRAE 90.1-2022, Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings.

.3 ASTM International (ASTM):

.1 ASTM B117-19, Standard Practice for Operating Salt Spray (Fog) Apparatus.

.4 British Standards Institution (BSI):

.1 BS EN 1886-2007, Ventilation For Buildings. Air Handling Units. Mechanical Performance.

.5 Underwriters Laboratories (UL):

.1 UL 1812-Edition 4, Ducted Heat Recovery Ventilators.

.2 UL 1995-Edition 5, Heating and Cooling Equipment

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Submit manufacturer's instructions, printed product literature, and data sheets for energy recovery equipment and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Indicate following:

.1 General layout drawing with plan and elevation views including all relevant dimensions.

.2 Performance schedule including airflow, heating and cooling capacities, electrical data, and unit weight.

.3 Energy recovery wheel performance characteristics: sensible for HRV (and latent for ERV as applicable) recovery efficiency, frost point based on design conditions, speed range in RPM

.4 Fan energy consumption: kW of supply and exhaust fans at design condition and watts per LPS (CFM) calculation defined as: (design condition supply fan watts + design condition exhaust fan watts)/supply fan airflow.

.5 Full fan curve.

.6 Sound power data by octave band for all openings and radiated through cabinet.

.7 Electrical schematics including field wiring connections.

.8 Component details including construction method and materials.

.9 Control point schematic and complete written sequence of operation.

.10 Curb/pad mounting details.

1.3 MAINTENANCE MATERIAL SUBMITTALS

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

.2 Provide 1 spare sets of filters.

.3 Provide list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing, or replacing, for placement into operating manual.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment, and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 GENERAL

.1 Performance: Comply with ASHRAE 90.1.

.2 Safety: Entire unit shall be UL 1812 or UL 1995 certified and bear a certification label by ETL, UL or CSA.

2.2 AIR TO AIR FIXED PLATE EXCHANGER

.1 Heat transfer surfaces: Molecular sieve type, for latent and sensible heat transfer, edge sealed.

.2 Cross contamination: not permitted.

.3 Condensate drain: NPS 2.

.4 Removable access panels.

.5 Performance characteristics: as indicated.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for energy recovery equipment installation in accordance with manufacturer's written instructions:

.1 Visually inspect substrate in presence of HRCE Representative.

.2 Inform HRCE Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from HRCE Representative.

3.2 INSTALLATION

.1 Install in accordance with manufacturers recommendations.

.2 Support independently of adjacent ductwork with flexible connections.

3.3 FIELD QUALITY CONTROL

.1 Engage factory authorized service technician to start up and commission units. Provide start up report to HRCE Representative.

3.4 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment in accordance with Section 01 74 00 - Cleaning.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 CSA Group (CSA):

.1 CSA B52-05 (R2009), Mechanical Refrigeration Code.

.2 CAN/CSA-C656-05 (R2010), Performance Standard for Single Package Central Air-Conditioners and Heat Pumps.

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 air conditioning components and accessories, and include product characteristics, performance criteria, physical size, finish, and limitations.

.3 Shop Drawings:

.1 Indicate on drawings:

.1 Major components and accessories including sound power levels of units.

.2 Type of refrigerant used.

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 VRF Equipment for incorporation into manual.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Material & Equipment, and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 VRF SYSTEM

.1 Outdoor Unit (OU-#)

.1 General:

.1 Variable Refrigerant flow system. The system can operate in either heating mode or cooling mode or configured to operate cooling and heating simultaneously in a heat recovery mode.

.2 In Heat Pump configuration, the system can operate in heating only mode (i.e. all indoor units in heating mode) from -25 °C to 16 °C outdoor ambient wet bulb. Heat Pump systems can operate in cooling mode from -5 °C to 50 °C outdoor ambient dry bulb.

.3 Use factory supplied headers and y-fittings.

.2 Casing:

.1 Outdoor units are constructed with galvanized steel, bonderized, and finished with baked enamel paint.

.2 Each frame has a removable inspection panel to allow access to service tool connections, DIP switches, auto addressing, and error codes.

.3 The entire front panel of the outdoor unit is removable for maintenance.

.4 Outdoor unit frames are completely factory assembled, piped, and wired. Dual and triple frame outdoor units are field piped with factory-designed and supplied outdoor unit Y-branch kits to manifold them together into a single refrigerant circuit.

.3 Refrigerant System:

.1 The refrigeration system consists of a single refrigeration circuit and uses R32 refrigerant.

.2 The outdoor unit is provided with factory-installed components, including a refrigerant strainer, check valves, oil separator, oil level sensor, accumulator, four-way reversing valves, electronically controlled expansion valve (EEV), high and low side charging ports, high-pressure safety switch, service valves, and interconnecting piping. Also included is an integral subcooler assembly consisting of a double spiral tube-type subcooling heat exchanger and EEV providing modulation of up to -5 ºC subcooling.

.4 Compressors:

.1 All 1-phase outdoor unit frames are equipped with one hermetic digitally controlled inverter driven scroll compressor to modulated capacity (variable from 12 to 165 Hz, modulate in 1.0 Hz increments).

.5 Outdoor Unit Coil:

.1 The outdoor unit coils are of a nonferrous construction with louvered aluminum fins on copper tubing, and are protected by a metal guard.

.2 Coil fins have a factory applied corrosion resistant hydrophilic coating.

.6 Fans and Motors:

.1 Outdoor unit frames include one direct drive, variable speed propeller type fan. All fan motors have inherent protection, permanently lubricated bearings, and are variable speed with a maximum speed up to 750 rpm. Raised guards are provided to limit contact with moving parts. Outdoor units have horizontal discharge airflow.

.2 Fan guards are provided to limit contact with moving parts. All Heat Pump outdoor units have vertical discharge airflow.

.7 Electrical

.1 Outdoor units are 208 - 230 V/60 Hz/1-phase. The unit include over/under voltage protection.

.8 Controls:

.1 Outdoor units are factory wired with necessary electrical control components, integral microprocessors, printed circuit boards, thermistors, sensors, terminal blocks, and power lugs. The control circuit between the indoor units, heat recovery unit(s) (heat recovery systems only), and the outdoor unit is an RS-485 daisy chain communication bus. The cable is two conductor, twisted, stranded, and shielded, 18 AWG. Microprocessor-based algorithms provide component protection, soft-start capability, refrigeration system pressure, temperature, defrost, and ambient control.

.2 Ducted Indoor Unit (IU-#):

.1 Casing:

.1 The case is designed to mount concealed above the finished ceiling. Fan supply air is front horizontal with a rear horizontal field convertible to a bottom return. The unit is manufactured with coated metal. Cold surfaces are covered with a polystyrene insulating material. The case is provided with hanger brackets designed to support the unit weight on four corners. Hanger brackets have pre-punched holes designed to accept field supplied all-thread rod hangers.

.2 Fan Assembly and Control:

.1 The unit has fans made of high-strength ABS HT-700 polymeric resin. Fans are directly driven and mounted on a common shaft. The fan motor is a Brushless Digitally-Controlled (BLDC) design with permanently lubricated and sealed ball bearings. The fan motor includes thermal, overcurrent, and low RPM protection. The fan/motor assembly is mounted on vibration attenuating rubber grommets. The fan impeller is statically and dynamically balanced. The fan speed is controlled using a microprocessor based direct digital control algorithm that provides a high fan speed in cooling thermal ON and low fan speed in cooling thermal OFF, high fan speed in heating thermal ON and fan off in heating thermal OFF. The fan speeds can be field adjusted between low, medium, and high speeds, and DIP switch settings will allow the fan to run constantly during defrost or oil return modes. Each setting can be field adjusted from the factory setting (RPM/ESP) to compensate for

resistance to airflow caused by field connected ductwork or other airflow restricting devices.

.3 Air Filter:

.1 Return air is filtered with a removable, washable filter with anti-fungal treatment.

.4 Condensate Pump:

.1 The indoor unit is provided with a factory installed and wired condensate lift/pump capable of providing a minimum 700 mm lift from the bottom exterior surface of the unit casing. The lift pump comes with a safety switch that will shut off indoor unit if condensate rises too high in the drain pan.

.5 Indoor Unit Coil:

.1 The indoor unit coil is constructed with grooved design copper tubes with slit coil fins, two (2) to three (3) rows, eighteen (18) to twenty-one (21) fins per inch.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for air conditioning components installation in accordance with manufacturer's written instructions:

.1 Visually inspect substrate in presence of HRCE Representative.

.2 Inform HRCE Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from HRCE Representative.

3.2 GENERAL

.1 Manufacturer to certify installation.

.2 Run drain line from cooling coil condensate drain pan to terminate over nearest floor drain.

3.3 EQUIPMENT PREPARATION

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

3.4 CLEANING

.1 Progress Cleaning: 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 or recycling in accordance with Section 01 74 19 - Waste Management and Disposal:

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

3.5 PROTECTION

.1 Protect installed products and components from damage during construction.

END OF SECTION

Part 1 General

1.1 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 fulfill 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:

.1 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.

.2 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.

.3 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.

1.2 DESIGN REQUIREMENTS

.1 Confirm with HRCE Representative that Design Criteria and Design Intents are still applicable.

.2 Commissioning personnel to be fully aware of and qualified to interpret Design Criteria and Design Intents.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Final Report: submit report to HRCE Representative:

.1 Include measurements, final settings, and certified test results.

.2 Bear signature of commissioning technician and supervisor

.3 Report format to be approved by HRCE Representative before commissioning is started.

.4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments, and modifications to EMCS as set during commissioning, and submit to HRCE Representative in accordance with Section 01 78 00 - Closeout Submittals.

.5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions, or energy consumption.

1.4 CLOSEOUT SUBMITTALS

.1 Provide documentation, O&M Manuals, and training of O&M personnel for review of HRCE Representative before interim acceptance in accordance with Section 01 78 00 - Closeout Submittals.

1.5 COMMISSIONING

.1 Do commissioning in accordance with Section 01 91 13 - General Commissioning Requirements.

.2 Carry out commissioning under direction and in presence of HRCE Representative.

.3 Inform and obtain approval from HRCE Representative in writing at least 14 days prior to commissioning or each test. Indicate:

.1 Location and part of system to be tested or commissioned.

.2 Testing/commissioning procedures, anticipated results.

.3 Names of testing/commissioning personnel.

.4 Correct deficiencies, re-test in presence of HRCE Representative until satisfactory performance is obtained.

.5 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.

.6 Load system with project software.

.7 Perform tests as required.

1.6 COMPLETION OF COMMISSIONING

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

1.7 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.

Part 2 Products

2.1 EQUIPMENT

.1 Provide sufficient instrumentation to verify and commission the installed system.

.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.

Part 3 Execution

3.1 PROCEDURES

.1 Test each system independently and then in unison with other related systems.

.2 Commission each system using procedures prescribed by the HRCE Representative.

.3 Commission integrated systems using procedures prescribed by HRCE Representative.

.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.

3.2 FIELD QUALITY CONTROL

.1 Pre-Installation Testing:

- .1 General: consists of field tests of equipment just prior to installation.
- .2 Testing may be on site or at Contractor's premises as approved by HRCE Representative.
- .3 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.
- .4 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).
- .5 Additional instruments to include:
  - .1 DP transmitters.
  - .2 VAV supply duct SP transmitters.
  - .3 DP switches used for dirty filter indication and fan status.
- .6 In addition to test equipment, provide inclined manometer, digital micro-manometer, milli-amp meter, source of air pressure infinitely adjustable between 0 and 500 Pa, to hold steady at any setting and with direct output to milli-amp metre at source and to BECC.
- .7 After setting, test zero and span in 10% increments through entire range while both increasing and decreasing pressure.
- .8 HRCE Representative to mark instruments tracking within 0.5% in both directions as "approved for installation".
- .9 Transmitters above 0.5% error will be rejected.
- .10 DP switches to open and close within 2% of setpoint.

.2 Completion Testing:

- .1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.

.2 Include following activities:

.1 Test and calibrate field hardware including stand-alone capability of each controller.

.2 Verify each A-to-D convertor.

.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 Blow out flow measuring and static pressure stations with high pressure air at 700 kPa.

.12 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 on commissioning technician and HRCE Representative. This document will be used in final startup testing.

.3 Final Startup Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of HRCE Representative 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 HRCE Representative’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 HRCE Representative.

.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.

.4 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, and 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.

.5 HRCE Representative to verify reported results.

3.3 ADJUSTING

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

3.4 DEMONSTRATION

.1 Demonstrate to HRCE Representative 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

Part 1 General

1.1 DEFINITIONS

.1 CDL - Control Description Logic.

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

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures, 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 HRCE Representative 30 days prior to anticipated date of beginning of training:

.1 List name of trainer, and type of visual and audio aids to be used.

.2 Show co-ordinated interface with other EMCS mechanical and electrical training programs.

.3 Submit reports within one week after completion of training program that training has been satisfactorily completed.

1.3 QUALITY ASSURANCE

.1 Provide competent instructors thoroughly familiar with aspects of EMCS installed in facility.

1.4 INSTRUCTIONS

.1 Provide instruction to designated personnel in adjustment, operation, maintenance, and pertinent safety requirements of EMCS installed.

.2 Training to be project specific.

1.5 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).

1.6 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:

.1 Review contents of manual in detail to explain aspects of Operation and Maintenance (O&M).

1.7 TRAINING PROGRAM

.1 To be in 2 phases over 6-month period.

.2 Phase 1: 2-day program to begin before 30 day test period at time mutually agreeable to Contractor, HRCE Representative Commissioning Manager:

.1 Train O&M personnel in functional operations and procedures to be employed for system operation.

.2 Supplement with on-the-job training during 30 day test period.

.3 Include overview of system architecture, communications, operation of computer and peripherals, and report generation.

.4 Include detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.

.3 Phase 2: 5-day program to begin 8 weeks after acceptance for operators, equipment maintenance personnel and programmers:

.1 Provide multiple instructors on pre-arranged schedule. Include at least following:

.1 Operator training: provide operating personnel, maintenance personnel, and programmers with condensed version of Phase 1 training.

.2 Equipment maintenance training: provide personnel with 2 days training within 5-day period in maintenance of EMCS equipment, including general equipment layout, trouble shooting and preventive maintenance of EMCS components, maintenance and calibration of sensors and controls.

.3 Programmers: provide personnel with 2 days training.

1.8 ADDITIONAL TRAINING

.1 List courses offered by name, duration, and approximate cost per person per week. Note courses recommended for training supervisory personnel.

1.9 MONITORING OF TRAINING

.1 HRCE Representative to monitor training program and may modify schedule and content.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Project intent is to create a complete new BACnet compatible control system, fully integrating all building HVAC control systems.

.2 New field devices and low voltage/communication wiring shall be provided and installed by controls contractor. Coordinate with Division 26 for conduit installation requirements and 120 V wiring and connection locations.

1.2 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA):

.1 ANSI/ISA 5.5-1985, Graphic Symbols for Process Displays.

.2 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE):

.1 ANSI/IEEE 260.1-1993, American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).

.3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):

.1 ASHRAE STD 135-R2001, BACNET - Data Communication Protocol for Building Automation and Control Network.

.4 CSA Group (CSA):

.1 CAN/CSA-Z234.1-89 (R1995), Canadian Metric Practice Guide.

.5 Consumer Electronics Association (CEA):

.1 CEA-709.1-B-2002, Control Network Protocol Specification.

.6 Department of Justice Canada (Jus):

.1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.

.2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.

.7 Electrical and Electronic Manufacturers Association (EEMAC):

.1 EEMAC 2Y-1-1958, Light Grey Colour for Indoor Switch Gear.

.8 Green Building Initiative (GBI):

.1 Green Globes Design for New Construction and Major Renovations, Version 2.

.2 Green Globes for New Construction Technical Manual 2015.

.9 Health Canada/Workplace Hazardous Materials Information System (WHMIS):

.1 Safety Data Sheets (SDS).

.10 Transport Canada (TC):

.1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

1.3 ABBREVIATIONS AND ACRONYMS

.1 Acronyms used in EMCS:

.1 AEL - Average Effectiveness Level.

.2 AI - Analog Input.

.3 AIT - Agreement on International Trade.

.4 AO - Analog Output.

.5 BACnet - Building Automation and Control Network.

.6 BC(s) - Building Controller(s).

.7 BECC - Building Environmental Control Centre.

.8 CAD - Computer Aided Design.

.9 CDL - Control Description Logic.

.10 CDS - Control Design Schematic.

.11 COSV - Change of State or Value.

.12 CPU - Central Processing Unit.

.13 DI - Digital Input.

.14 DO - Digital Output.

.15 DP - Differential Pressure.

.16 ECU - Equipment Control Unit.

.17 EMCS - Energy Monitoring and Control System.

.18 HVAC - Heating, Ventilation, Air Conditioning.

.19 IDE - Interface Device Equipment.

.20 I/O - Input/Output.

.21 ISA - Industry Standard Architecture.

.22 LAN - Local Area Network.

.23 LCU - Local Control Unit.

.24 MCU - Master Control Unit.

.25 NAFTA - North American Free Trade Agreement.

.26 NC - Normally Closed.

.27 NO - Normally Open.

.28 OS - Operating System.

.29 O&M - Operation and Maintenance.

.30 OWS - Operator Work Station.

.31 PC - Personal Computer.

.32 PCI - Peripheral Control Interface.

.33 PCMCIA - Personal Computer Micro-Card Interface Adapter.

.34 PID - Proportional, Integral and Derivative.

.35 RAM - Random Access Memory.

.36 SP - Static Pressure.

.37 ROM - Read Only Memory.

.38 TCU - Terminal Control Unit.

.39 USB - Universal Serial Bus.

.40 UPS - Uninterruptible Power Supply.

.41 VAV - Variable Air Volume.

1.4 DEFINITIONS

.1 Point: may be logical or physical.

.1 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.

.2 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.

.1 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.

.2 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.

.3 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:

.1 AI (analog input).

.2 AO (analog output).

.3 DI (digital input).

.4 DO (digital output).

.5 Pulse inputs.

.4 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5:

.1 Printouts: to ANSI/IEEE 260.1.

.2 Refer also to Section 25 05 54 - EMCS: Identification.

1.5 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:

.1 Building Controllers.

.2 Control devices as listed in I/O point summary tables.

.3 OWS(s).

.4 Data communications equipment necessary to effect EMCS data transmission system.

.5 Field control devices.

.6 Software/Hardware complete with full documentation.

.7 Complete operating and maintenance manuals.

.8 Training of personnel.

.9 Acceptance tests, technical support during commissioning, and full documentation.

.10 Wiring interface co-ordination of equipment supplied by others.

.11 Miscellaneous work as specified in these sections and as indicated.

.3 Design Requirements:

.1 Design and provide conduit and wiring linking elements of system.

.2 Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed by HRCE Representative prior to installation.

.3 Location of controllers as reviewed by HRCE Representative prior to installation.

.4 Provide utility power to EMCS and emergency power to EMCS as indicated.

.5 Metric references: in accordance with CAN/CSA Z234.1.

.4 Language Operating Requirements:

.1 Provide English operator selectable access codes.

.2 Use non-linguistic symbols for displays on graphic terminals wherever possible. Other information to be in English.

.3 Operating system executive: provide primary hardware-to-software interface specified as part of hardware purchase with associated documentation to be in English.

.4 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.

.5 Include, in English:

.1 Input and output commands and messages from operator-initiated functions, field related changes, 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-definements).

.2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points. To be in English at specified OWS.

.3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, and maintenance generated logs.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures and 25 05 02 - EMCS: Submittals and Review Process.

.2 Quality Control:

.1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.

.2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.

.3 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.

.4 In lieu of such evidence, submit certificate from testing organization, approved by HRCE Representative, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.

.5 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.

.6 Permits and fees: in accordance with general conditions of contract.

.7 Submit certificate of acceptance from Authority Having Jurisdiction to HRCE Representative.

.8 Existing devices intended for re-use: submit test report.

1.7 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.

.5 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29 - Occupational Health and Safety Requirements.

1.8 DELIVERY, STORAGE AND HANDLING

.1 Material Delivery Schedule: provide HRCE Representative with schedule within 2 weeks after award of Contract.

.2 Waste Management and Disposal:

.1 Packaging Waste Management: remove for reuse and return of pallets, padding, crates, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal corrugated cardboard, plastic, paper, polystyrene packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Separate for reuse or recycling and place in designated containers Steel, Metal, Plastic waste in accordance with Waste Management Plan.

.5 Place materials defined as hazardous or toxic in designated containers.

.6 Handle and dispose of hazardous materials in accordance with Regional and Municipal, CEPA, TDGA regulations.

.7 Label location of salvaged material's storage areas and provide barriers and security devices.

.8 Ensure emptied containers are sealed and stored safely.

.9 Divert unused metal materials from landfill to metal recycling facility as approved by HRCE Representative.

.10 Fold up metal, plastic banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 EQUIPMENT

.1 Control Network Protocol and Data Communication Protocol: to CEA 709.1 ASHRAE STD 135.

.2 Complete list of equipment and materials to be used on project and forming part of tender documents by adding manufacturer's name, model number and details of materials, and submit for approval.

Part 3 Execution

3.1 MANUFACTURER'S RECOMMENDATIONS

.1 Installation: to manufacturer's recommendations.

END OF SECTION

Part 1 General

1.1 DEFINITIONS

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

1.2 DESIGN REQUIREMENTS

.1 Preliminary Design Review: to contain following contractor and systems information:

- .1 Location of local office.
- .2 Description and location of installing and servicing technical staff.
- .3 Location and qualifications of programming design and programming support staff.
- .4 List of spare parts.
- .5 Location of spare parts stock.
- .6 Names of Subcontractors and site-specific key personnel.
- .7 Sketch of site-specific system architecture.
- .8 Specification sheets for each item including memory provided, programming language, speed, and type of data transmission.
- .9 Descriptive brochures.
- .10 Sample CDL and graphics (systems schematics).
- .11 Response time for each type of command and report.
- .12 Item-by-item statement of compliance.
- .13 Proof of demonstrated ability of system to communicate utilizing BACnet.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures and coordinate with requirements in this Section.

.2 Submit preliminary design document within 5 working days after tender closing and before contract award, for review by HRCE Representative.

.3 Shop Drawings to consist of 3 hard copies and 1 soft copy of design documents, shop drawings, product data, and software.

.4 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.

.5 Soft copy to be in AutoCAD - Latest Version and Microsoft Word Latest Version format, structured using menu format for easy loading and retrieval on OWS.

1.4 PRELIMINARY SHOP DRAWING REVIEW

.1 Submit preliminary shop drawings within 30 working days of award of contract and include following:

- .1 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, and other data to establish compliance.

.2 Detailed system architecture showing all points associated with each controller.

.3 Spare point capacity of each controller by number and type.

.4 Controller locations.

.5 Auxiliary control cabinet locations.

.6 Single line diagrams showing cable routings, conduit sizes, spare conduit capacity between control centre, field controllers and systems being controlled.

.7 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).

.8 Dampers: sketches showing module assembly, interconnecting hardware, operator locations, operator spring range, pilot range, required torque, and actual torque.

.9 Flow measuring stations: complete schedule listing designation, service, point ID, manufacturer, model, size, velocity at design flow rate, manufacturer, model, and range of velocity transmitter.

1.5 DETAILED SHOP DRAWING REVIEW

.1 Submit detailed shop drawings within 60 working days after award of contract and before start of installation and include following:

.1 Corrected and updated versions (hard copy only) of submissions made during preliminary review.

.2 Wiring diagrams.

.3 Piping diagrams and hook-ups.

.4 Interface wiring diagrams showing termination connections and signal levels for equipment to be supplied by others.

.5 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.

.6 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.

.7 Graphic system schematic displays of water, air, and VRF systems with point identifiers and textual description of system, and typical floor plans as specified.

.8 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.

.9 Listing and example of specified reports.

.10 Listing of time of day schedules.

.11 Mark up to-scale construction drawing to detail control room showing location of equipment and operator work space.

.12 Type and size of memory with statement of spare memory capacity.

.13 Full description of software programs provided.

.14 Sample of "Operating Instructions Manual" to be used for training purposes.

.15 Outline of proposed start-up and verification procedures. Refer to Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

1.6 QUALITY ASSURANCE

.1 Preliminary Design Review Meeting: Convene meeting within 45 working days of award of contract to:

.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".

.2 Contractor's programmer to attend meeting.

.3 HRCE Representative retains right to revise sequence or subsequent CDL prior to software finalization without cost to HRCE Representative

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section includes:

.1 Requirements and procedures for final control diagrams and Operation and Maintenance (O&M) Manual, for building Energy Monitoring and Control System (EMCS) Work.

1.2 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.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 78 00 - Closeout Procedures, supplemented and modified by requirements of this Section.

.2 Submit As-built drawings to HRCE Representative in English.

.3 Provide soft copies and hard copies in hard-back, 50 mm 3 ring, D-ring binders:

.1 Binders to be 2/3 maximum full.

.2 Provide index to full volume in each binder.

.3 Identify contents of each manual on cover and spine.

.4 Provide Table of Contents in each manual.

.5 Assemble each manual to conform to Table of Contents with tab sheets placed before instructions covering subject.

1.4 AS-BUILTS

.1 Provide 1 copy of detailed shop drawings generated in Section 25 05 02 - EMCS: Submittals and Review Process and include:

.1 Changes to Contract Documents as well as addenda and contract extras.

.2 Changes to interface wiring.

.3 Routing of conduit, wiring and control air lines associated with EMCS installation.

.4 Locations of obscure devices to be indicated on drawings.

.5 Listing of alarm messages.

.6 Panel/circuit breaker number for sources of normal/emergency power.

.7 Names, addresses, and telephone numbers of each Subcontractor having installed equipment, local representative for each item of equipment, each system.

.8 Test procedures and reports: provide records of start-up procedures, test procedures, checkout tests and final commissioning reports as specified in Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

.9 Basic system design and full documentation on system configuration.

.2 Submit for final review by HRCE Representative.

.3 Provide before acceptance 4 Hard and 1 soft copy incorporating changes made during final review.

1.5 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 2 complete sets of hard and soft copies before 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:

.1 Functional description of theory of operation.

.2 Design philosophy.

.3 Specific functions of design philosophy and system.

.4 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.

.5 Explicit description of hardware and software functions, interfaces and requirements for components in functions and operating modes.

.6 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:

.1 Complete step-by-step procedures for operation of system including required actions at each OWS.

.2 Operation of computer peripherals, input and output formats.

.3 Emergency, alarm, and failure recovery.

.4 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:

.1 Documentation of theory, design, interface requirements, functions, including test and verification procedures.

.2 Detailed descriptions of program requirements and capabilities.

.3 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.

.4 Software modules, fully annotated source code listings, error free object code files ready for loading via peripheral device

.5 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.

.6 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:

.1 Provisions and procedures for planning, implementing and recording hardware and software modifications required during operating lifetime of system.

.2 Information to ensure coordination 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.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 CSA Group (CSA):

.1 CSA C22.1-02, The Canadian Electrical Code, Part I (19th Edition), Safety Standard for Electrical Installations.

1.2 DEFINITIONS

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

1.3 SYSTEM DESCRIPTION

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

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures supplemented and modified by requirements of this Section.

.2 Submit to HRCE Representative for approval samples of nameplates, identification tags, and list of proposed wording.

Part 2 Products

2.1 NAMEPLATES FOR PANELS

.1 Identify by plastic laminate, 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.

2.2 NAMEPLATES FOR FIELD DEVICES

.1 Identify by plastic encased cards attached by 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.

2.3 NAMEPLATES FOR ROOM SENSORS

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

.2 Location: as directed by HRCE Representative.

.3 Letter size: to suit, clearly legible.

2.4 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" as reviewed by HRCE Representative.

2.5 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 Power wiring: identify circuit breaker panel/circuit breaker number inside each EMCS panel.

2.6 CONDUIT

.1 Colour code EMCS conduit.

.2 Pre-paint box covers and conduit fittings.

.3 Coding: use fluorescent orange paint and confirm colour with HRCE Representative during "Preliminary Design Review".

Part 3 Execution

3.1 NAMEPLATES AND LABELS

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

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI):

.1 ANSI/ASME B16.22-2013, Wrought Copper and Copper Alloy Solder Joint Pressures Fittings.

.2 ANSI C2-1990, National Electrical Safety Code.

.3 ANSI/NFPA 70-1990, National Electrical Code.

.2 CSA Group (CSA):

.1 CSA C22.1-12.

.2 CAN/CSA-C22.3 No. 7-10, Underground Systems.

.3 CAN/CSA C22.2 No. 45.1-07 (R2012), Electrical Rigid Metal Conduit.

.4 CAN/CSA C22.2 No. 56-13, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.

.5 CAN/CSA C22.2 No. 83-M1985 (R2013), Electrical Metallic Tubing.

.6 CAN/CSA-C22.3 No. 1-10, Overhead Systems.

1.2 SYSTEM DESCRIPTION

.1 Electrical:

.1 Provide power wiring from existing emergency power panels to EMCS field panels. Circuits to be for exclusive use of EMCS equipment. Panel breakers to be identified on panel legends tagged and locks applied to breaker switches.

.2 Hard wiring between field control devices and EMCS field panels.

.3 Communication wiring between EMCS field panels, MCUs, LCUs, ECUs, and TCUs.

.4 VRF system control wiring between WSVRF units, Branch Box Controllers, Indoor Units, and BACnet integration controller.

.5 Starters to provide for EMCS as indicated in I/O Summaries and as indicated.

.6 Refer to wiring diagrams and flow diagrams in drawing package.

.2 Mechanical:

.1 Pipe Taps Required for EMCS equipment will be supplied by EMCS Contractor and installed by Division 23.

.2 Wells, control valves, and flowmeters shall be supplied by EMCS Contractor and installed by Division 23.

.3 Installation of air flow stations, dampers, and other devices requiring sheet metal trades to be mounted by Division 23. Costs to be carried by designated trade.

.4 Air flow DP sensor, actuator, and associated vav controls to be supplied and installed by EMCS contractor. Tubing from air probe to DP sensor as well as installation and adjustment of air flow sensors and actuators to be the responsibility of EMCS contractor. Coordinate air flow adjustments with balancing trade.

.5 All other devices/controllers identified on drawings and elsewhere in specifications shall be supplied and installed by EMCS Contractor.

.3 Structural:

.1 Special steelwork as required for installation of work.

1.3 PERSONNEL QUALIFICATIONS

.1 Qualified supervisory personnel to:

.1 Continuously direct and monitor all work.

.2 Attend site meetings.

1.4 EXISTING CONDITIONS

.1 Repair all surfaces damaged during execution of work.

.2 Turn over to HRCE Representative existing materials removed from work not identified for re-use.

Part 2 Products

2.1 SPECIAL SUPPORTS

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

2.2 WIRING

.1 As per requirements of Division 26.

.2 For 70 V and above copper conductor with chemically cross-linked thermosetting polyethylene insulation rated RW90 and 600 V. Colour code to CSA 22.1.

.3 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. All other cases use FT4 wiring.

.4 Sizes:

.1 120 V Power supply: to match or exceed breaker, size #12 minimum.

.2 Wiring for safeties/interlocks for starters, motor control centres, to be stranded, #14 minimum.

.3 Field wiring to digital device: 20 AWG stranded twisted pair.

.4 Analog input and output: shielded #20 minimum stranded twisted pair. Wiring must be continuous without joints.

.5 More than 4 conductors: #22 minimum solid copper.

.5 Terminations:

.1 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.

2.3 CONDUIT

.1 As per requirements of Division 26.

.2 Electrical metallic tubing to CAN/CSA C22.2 No. 83. Flexible and liquid tight flexible metal conduit to CAN/CSA C22.2 No. 56. Rigid steel threaded conduit to CAN/CSA C22.2 No. 45.1.

.3 Junction and pull boxes: welded steel:

.1 Surface mounting cast FS: screw-on flat covers.

.2 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 and fittings:

.1 Bushings and connectors: with nylon insulated throats.

.2 With push pennies to prevent entry of foreign materials.

.7 Fittings for rigid conduit:

.1 Couplings and fittings: threaded type steel.

.2 Double locknuts and insulated bushings: use on sheet metal boxes.

.3 Use factory "ells" where 90 degree bends required for 25 mm and larger conduits.

.8 Fittings for thin wall conduit:

.1 Connectors and couplings: steel, set screw type.

2.4 SUPPORTS FOR CONDUIT, FASTENINGS, AND EQUIPMENT

.1 Solid masonry, tile, and plastic surfaces: lead anchors or nylon shields:

.1 Hollow masonry walls, suspended drywall ceilings: toggle bolts.

.2 Exposed conduits or cables:

.1 50 mm diameter and smaller: one-hole steel straps.

.2 Larger than 50 mm diameter: two-hole steel straps.

.3 Suspended support systems:

.1 Individual cable or conduit runs: support with 6 mm diameter threaded rods and support clips.

.2 Two or more suspended cables or conduits: support channels supported by 6 mm diameter threaded rod hangers.

Part 3 Execution

3.1 INSTALLATION

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

3.2 SUPPORTS

.1 Install special supports as required and as indicated.

3.3 ELECTRICAL GENERAL

.1 Do complete installation in accordance with requirements of:

.1 Division 26, this specification.

.2 CSA 22.1 Canadian Electrical Code.

.3 ANSI/NFPA 70.

.4 ANSI C2.

.2 Fully enclose or properly guard electrical wiring, terminal blocks, high voltage above 70 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 1,000 and 2,000 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.

3.4 CONDUIT SYSTEM

.1 Communication wiring shall be installed in conduit. Provide complete conduit system to link Building Controllers to BECC. Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems. Maximum conduit fill 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 HRCE 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 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:

.1 Provide metal brackets, frames, hangers, clamps and related types of support structures as indicated and as required to support cable and conduit runs.

.2 Provide adequate support for raceways and cables, sloped vertically to equipment.

.3 Use supports or equipment installed by other trades for conduit, cable, and raceway supports only after written approval from HRCE 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 HRCE 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:

.1 Install in inconspicuous but accessible locations.

.2 Support boxes independently of connecting conduits.

.3 Fill boxes with paper or foam to prevent entry of construction material.

.4 Provide correct size of openings. Reducing washers not permitted.

.5 Mark location of pull boxes on record drawings.

.6 Identify AC power junction boxes, by panel and circuit breaker.

.16 Install bonding conductor for 120 volt and above in conduit.

3.5 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:

.1 Circuits are continuous, free from shorts, unspecified grounds.

.2 Resistance to ground of all circuits is greater than 50 Megohms.

.5 Provide HRCE 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.

3.6 GROUNDING

.1 Install complete, permanent, and 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.

3.7 TESTS

.1 General:

.1 Give 14 days written notice of intention to test.

.2 Conduct in presence of HRCE Representative and Authority Having Jurisdiction.

.3 Conceal work only after tests satisfactorily completed.

.4 Report results of tests to HRCE Representative in writing.

.5 Preliminary tests:

.1 Conduct as directed to verify compliance with specified requirements.

.2 Make needed changes, adjustments, and replacements.

.3 Insulation resistance tests:

.1 Megger all circuits, feeders, and equipment for 120 - 600 V with 1,000 V instrument. Resistance to ground to be more than required by Code before energizing.

.2 Test insulation between conductors and ground, efficiency of grounding system to satisfaction of HRCE Representative and Authority Having Jurisdiction.

3.8 IDENTIFICATION

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

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Requirements and procedures for warranty and activities during warranty period and service contracts, for building Energy Monitoring and Control System (EMCS).

1.2 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.

1.3 REFERENCE STANDARDS

.1 CSA Group (CSA):

.1 CSA Z204-94, Guidelines for Managing Indoor Air Quality in Office Buildings

1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Submit detailed preventative maintenance schedule for system components to HRCE Representative.

.3 Submit detailed inspection reports to HRCE Representative.

.4 Submit dated, maintenance task lists to HRCE Representative and include the following sensor and output point detail, as proof of system verification:

.1 Point name and location.

.2 Device type and range.

.3 Measured value.

.4 System displayed value.

.5 Calibration detail

.6 Indication if adjustment required,

.7 Other action taken or recommended.

.5 Submit network analysis report showing results with detailed recommendations to correct problems found.

.6 Records and logs: in accordance with Section 01 78 00 - Closeout Submittals.

.1 Maintain records and logs of each maintenance task on site.

.2 Organize cumulative records for each major component and for entire EMCS chronologically.

.3 Submit records to HRCE Representative, after inspection indicating that planned and systematic maintenance have been accomplished.

.7 Revise and submit to HRCE Representative in accordance with Section 01 78 00 - Closeout Submittals “As-built drawings" documentation and commissioning reports to reflect changes, adjustments and modifications to EMCS made during warranty period.

1.5 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:

.1 Initiate service calls when EMCS is not functioning correctly.

.2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.

.3 Furnish HRCE Representative with telephone number where service personnel may be reached at any time.

.4 Service personnel to be on site ready to service EMCS within 2 hours after receiving request for service.

.5 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:

.1 Serial number identifying component involved.

.2 Location, date and time call received.

.3 Nature of trouble.

.4 Names of personnel assigned.

.5 Instructions of work to be done.

.6 Amount and nature of materials used.

.7 Time and date work started.

.8 Time and date of completion.

.5 Provide system modifications in writing:

.1 No system modification, including operating parameters and control settings, to be made without prior written approval of HRCE Representative.

1.6 SERVICE CONTRACTS

.1 Provide in-depth technical expertise and assistance to HRCE Representative and Commissioning Manager in preparation and implementation of service contracts and in-house preventive maintenance procedures.

.2 Service Contracts to include:

.1 Annual verification of site points for operation and calibration.

.2 2 visits per year.

.3 10 responses to emergency calls during day, per year.

.4 10 responses to emergency calls during silent hours per year.

.5 Complete inventory of installed system.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 SITE 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 HRCE Representative as described in Submittal article.

.2 Perform inspections during regular working hours, 0800 to 1630 h, Monday through Friday, excluding statutory holidays.

.3 Following inspections are minimum requirements and should not be interpreted to mean satisfactory performance:

.1 Perform calibrations using test equipment having traceable, certifiable accuracy at minimum 50% greater than accuracy of system displaying or logging value.

.2 Check and Calibrate each site input/output device in accordance with CSA Z204.

.3 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:

.1 Perform visual, operational checks to BC's, peripheral equipment, interface equipment, and other panels.

.2 Check equipment cooling fans as required.

.3 Visually check for mechanical faults, air leaks, and proper pressure settings on pneumatic components.

.4 Review system performance with HRCE Representative to discuss suggested or required changes.

.5 Major inspections to include, but not limited to:

.1 Minor inspection.

.2 Clean OWS(s) peripheral equipment, BC(s), interface and other panels, micro-processor interior, and exterior surfaces.

.3 Check signal, voltage, and system isolation of BC(s), peripherals, interface, and other panels.

.4 Verify calibration/accuracy of each input and output device and recalibrate or replace as required.

.5 Provide mechanical adjustments and necessary maintenance on printers.

.6 Run system software diagnostics as required.

.7 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:

.1 Test weather-sensitive systems twice: first at near winter design conditions and secondly under near summer design conditions.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Hardware and software requirements for an Operator Work Station (OWS) in a Building Energy Monitoring and Control System (EMCS), including primary, secondary, portable, and remote OWS's.

1.2 DEFINITIONS

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

.2 Secondary OWS: serves as backup to primary OWS, is storage and retrieval facility of soft copy of as-built contractor supplied data as described in Section 25 05 03 - EMCS: Project Record Documents.

.3 Portable OWS: used as remote dial-up OWS with same capabilities as primary OWS including graphic display.

.4 Remote Auxiliary OWS: performs identical user interface functions as primary OWS.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Make submittals in accordance with Section 25 05 02 - EMCS: Submittals and Review Process.

1.4 ENVIRONMENTAL CONDITIONS

.1 OWS to operate in conditions of 10 °C to 32 °C and 20% to 90% non-condensing RH.

1.5 MAINTENANCE

.1 Provide maintenance in accordance with Section 25 05 03 - EMCS: Project Record Documents.

Part 2 Products

2.1 OWS HARDWARE

.1 PC system to include:

.1 Processor: Pentium IV micro-processor, operating at minimum clock speed of 2 Gigahertz, capable of supporting software necessary to perform functions specified in this section. System backplane bus (100 Megahertz) to support PCI and ISA boards.

.2 Internal clock.

.1 Uninterruptible clock: accuracy of plus or minus 5 seconds/month, capable of deriving year/month/day/hour/minute/second.

.2 Rechargeable batteries: to provide minimum 48 hours clock operation in event of power failure.

.3 Asynchronous interfaces for connection to listed peripheral devices including LAN and remote devices.

.2 Power supply unit to accept 120 V 60 Hz source and include line surge and low voltage protection for processor and its peripherals.

.3 Include UPS to provide 5 minutes minimum operation of PC, CRT and communication and peripheral devices; applies to fixed (non portable) OWSs and peripherals.

2.2 OWS PC COMPONENTS

.1 Primary OWS: IBMPC compatible with following as minimum:

.1 IDE Disk drive controller to support 4 drives:

.1 20 GB hard disk drive, 12 ms.

.2 1 3.5" 144 MB floppy disk drive.

.2 256 MB RAM minimum.

.3 Enhanced 101 key keyboard.

.4 PS2 mouse.

.5 Colour monitor: 17". Flat panel display TFT, resolution 1280 X 1040, dot pitch 0.26 mm, colour support 24 bit,

.6 Video card with 32 MB video RAM.

.7 2 Parallel Ports to support printers.

.8 2 USB ports or 2 serial ports.

.9 Include two 2 spare expansion slots in system for PWGSC's use.

.10 Internal Modem - 56 k.

.11 PCI Ethernet LAN Adapter to connect to local Ethernet LAN network.

.12 200 W minimum power supply.

2.3 CONTROL DESK CONSOLE

.1 Capable of accommodating OWS and peripheral equipment specified with provision for operator desk work space.

.2 Desk: steel office type, standard sizes 1 m x 2 m, factory-made, computer type, for equipment mounting, with drawers on one side:

.1 Keyboards to be in separate pull-out drawer.

.2 Include above desk shelving to support contractor supplied manuals.

.3 Chair: upholstered, swivel type, with adjustable arms, back and seat, pneumatic seat height adjustment, and 5 castors.

2.4 OPERATING SYSTEM (OS) OR EXECUTIVE

.1 OS to support complement of hardware terminals and software programs specified.

.2 OS to be true multitasking operating environment:

.1 MS DOS or PC DOS based software platforms not permitted.

.3 OWS software to operate in "Windows" based operating environment: Windows 2000, XP, or Unix "X' Windows based system.

2.5 OWS CONTROL SOFTWARE

.1 OWS is not to form part of real-time control functions either directly or indirectly or as part of communication link. Real-time control functions to reside in MCUs, LCUs, and TCUs with peer to peer communication occurring at MCU to MCU device level.

.2 Time Synchronization Module:

.1 System to provide Time Synchronization of real-time clocks in controllers.

.2 System to perform this feature on regular scheduled basis and on operator request.

.3 User Display Interface Module:

.1 OWS software to support "Point Names" as defined in Section 25 05 01 - EMCS: General Requirements.

.2 Upon operator's request in either text, graphic, or table mode, system to present condition of single point, system, area, or connected points on system to OWS. Display analog values digitally to 1 place of decimal with negative sign as required. Update displayed analog values and status when new values received. Flag points in alarm by blinking, reverse video, different colour, bracketed, or other means to differentiate from points not in alarm. For systems supporting COSV, refresh rate of screen data not to exceed 5 seconds from time of site change and system is to execute supervisory background scan every 20 seconds to verify point data value. For other systems refresh rate not to exceed 5 seconds for points displayed. Initial display of new system graphic display (with up to 30 active points), including presentation of associated dynamic data not to exceed 8 seconds.

.4 General Event Log Module: to record system activities occurring at OWS or elsewhere in system including:

.1 Operator Log-in from user interface device.

.2 Communication messages: errors, failures and recovery.

.3 Event notifications and alarms by category.

.4 Record of operator initiated commands.

.5 General Event Log:

.1 Hold minimum of 4 months information and be readily accessible to operator.

.2 Able to be archived as necessary to prevent loss of information.

.6 Operator Control Software Module: to support entry of information into system from keyboard and mouse, disk, or from another network device. Display of information to user; dynamic displays, textual displays, and graphic displays to display logging and trending of system information and following tasks:

.1 Automatic logging of digital alarms and change of status messages.

.2 Automatic logging of analog alarms.

.3 System changes: alarm limits, set-points, and alarm lockouts.

.4 Display specific point values, states as selected.

.5 Provide reports as requested and on scheduled basis when required.

.6 Display graphics as requested, and on alarm receptions (user's option).

.7 Display list of points within system.

.8 Display list of systems within building.

.9 Direct output of information to selected peripheral device.

.10 On-line changes:

.1 Alarm limits.

.2 Setpoints.

.3 Deadbands.

.4 Control and change of state changes.

.5 Time, day, month, and year.

.6 Control loop configuration changes for controller-based CDLs.

.7 Control loop tuning changes.

.8 Schedule changes.

.9 Changes, additions, or deletions, of points, graphics, for installed and future systems.

.11 According to assigned user privileges (password definition) following functions are to be supported:

.1 Permit operator to terminate automatic (logic based) control and set value of site point to operator selected value. These values or settings to remain in effect until returned to automatic (logic based) control by operator.

.2 Requests for status, analog values, graphic displays, logs, and controls to be through user interface screens.

.12 Software and tools utilized to generate, modify and configure building controllers to be installed and operational on the OWS.

.7 Dial-up host Module for off site OWSs:

.1 Operators at dial-up OWS to be able to perform control functions, report functions, data base generation and modification functions as described for OWS's connected via LAN. Provide routines to automatically answer calls and either file or display information sent from remote panels.

.2 Operator to be able to access remote buildings by selection of facility by its logical name. Dial-up module to maintain user-definable cross-reference of buildings and associated telephone numbers without manual dialing.

.3 Local OWS may serve as dial-up host for remotely connecting OWSs, remote controllers or networks. Alarms and data file transfers handled via dial-up transactions must not interfere with local LAN activity. LAN activity not to prevent work-station from handling incoming calls.

.8 Message Handling Module - and Error Messages: to provide message handling for following conditions:

.1 Message and alarm buffering to prevent loss of information.

.2 Error detection correction and retransmission to guarantee data integrity.

.3 Informative messages to operator for data error occurrences, errors in keyboard entry, failure of equipment to respond to requests or commands and failure of communications between EMCS devices.

.4 Default device definition to be implemented to ensure alarms are reported as quickly as possible in event of faulty designated OWS.

.9 Access Control Module:

.1 Minimum 5 levels of password access protection to limit control, display, or data base manipulation capabilities. Following is preferred format of progression of password levels:

.1 Guest: no password data access and display only.

.2 Operator Level: full operational commands including automatic override.

.3 Technician: data base modifications.

.4 Programmer: data base generation.

.5 Highest Level: system administration - password assignment addition, modification.

.2 User-definable, automatic log-off timers from 1 to 60 min. to prevent operators leaving devices on-line inadvertently. Default setting = 3 minutes.

.10 Trend Data Module: includes historical data collection utility, trend data utility, control loop plot utility. Each utility to permit operator to add trend point, delete trend point, set scan rate:

.1 Historical data collection utility: collect concurrently operator selected real or calculated point values at operator selectable rate 30-480 minutes. Samples to include for each time interval (time-stamped), minimum present value, maximum present value, and average present value for point selected. Rate to be individually selectable for each point. Data collection to be continuous operation, stored in temporary storage until removed from historical data list by operator. Temporary storage to have at least 6 month capacity.

.2 Trend data utility: continuously collect point object data variables for variables from building controllers as selected by operator, including at minimum; present value of following point object types - DI, DO, AI, AO, set points value, calculated values. Trend data utility to have capacity to trend concurrently points at operator-selectable rate of 05 seconds to 3600 seconds, individually selectable for selected value, or use of COSV detection. Collected trend data to be stored on minimum 96 hours basis in temporary storage until removed from trend data list by operator. Option to archive data before overwriting to be available.

.3 Control loop plot utility: for AO Points provide for concurrent plotting of Measured value input - present value, present value of output, and AO setpoint. Operator selectable sampling interval to be selectable between 1 second to 20 seconds. Plotting utility to scroll to left as plot reaches right side of display window. Systems not supporting control loop plot as separate function must provide predefined groups of values. Each group to include values for one control loop display.

.4 Trend data Module to include display of historical or trend data to OWS screen in X Y plot presentation. Plot utility to display minimum of 6 historical points or 6 trend points concurrently or 1 Control Loop Plot. For display output of real time

trend data, display to automatically index to left when window becomes full. Provide plotting capabilities to display collected data based on range of selected value for (Y) component against time/date stamp of collected data for (X) component.

.5 Provide separate reports for each trend utility. Provide operator feature to specify report type, by point name and for output device. Reports to include time, day, month, year, report title, and operator's initials. Implement reports using report module. Ensure trend data is exportable to third party spreadsheet or database applications for PCs.

.11 Report Module: reports for energy management programs, function totalization, analog/pulse totalization and event totalization features available at MCU level. Refer also to Section 25 30 01 - EMCS: Building Controllers:

.1 Reports to include time, day, month, year, report title, and operator's initials.

.2 Software to provide capability to:

.1 Generate and format reports for graphical and numerical display from real time and stored data.

.2 Print and store reports as selected by operator.

.3 Select and assign points used in such reports.

.4 Sort output by area, system, as minimum.

.3 Periodic/automatic report:

.1 Generate specified report(s) automatically including options of start time and date, interval between reports (hourly, daily, weekly, monthly), output device. Software to permit modifying periodic/automatic reporting profile at any time.

.2 Reports to include:

.1 Power demand and duty cycle summary: see application program for same.

.2 Disabled "Locked-out" point summary: include point name, whether disabled by system or by operator.

.3 Run time summary: summary of accumulated running time of selected equipment. Include point name, run time to date, alarm limit setting. Run time to accumulate until reset individually by operator.

.4 Summary of run time alarms: include point name, run time to date, alarm limit.

.5 Summary of start/stop schedules: include start/stop times and days, point name.

.6 Motor status summary.

.4 Report types:

.1 Dynamic reports: system to printout or display of point object data value requested by operator. System to indicate status at time of request, when displayed, updated at operator selected time interval. Provide option for

operator selection of report type, by point name, and/or output device. Ensure reports are available for following point value combinations.

.2 Points in accessible from this OWS (total connected for this location), multiple "areas".

.3 Area (points and systems in area).

.4 Area and system (points in system).

.5 System (points by system type).

.6 System point (points by system and point object type).

.7 Area point (points by system and point object type).

.8 Point (points by point object type).

.5 Summary report: printout or display of point object data value selected by operator. Report header to indicate status at time of request. Ensure reports are available on same basis as dynamic reports. Provide option as to report type, point name, output device.

.6 Include preformatted reports as listed in Event/Alarm Module.

.12 Graphics Display Module: graphics software utility to permit user to create, modify, delete, file, and recall graphics required by Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation:

.1 Provide capacity for 100% expansion of system graphics. Graphic interface to provide user with multiple layered diagrams for site, building in plan view, floor furniture plan view and building systems, overlayed with dynamic data appropriately placed and permitting direct operator interaction. Graphic interface to permit operator to start and stop equipment, change set points, modify alarm limits, override system functions and points from graphic system displays by use of mouse or similar pointing device.

.2 Display specific system graphics: provide for manual and/or automatic activation (on occurrence of an alarm). Include capability to call up and cancel display of graphic picture.

.3 Library of pre-engineered screens and symbols depicting standard air handling components (fans, coils, filters, dampers, VAV), complete mechanical system components (chillers, boilers, pumps), electrical symbols.

.4 Graphic development, creation, modification package to use mouse and drawing utility to permit user to:

.1 Modify portion of graphic picture/schematic background.

.2 Delete graphic picture.

.3 Call up and cancel display of graphic picture.

.4 Define symbols.

.5 Position and size symbols.

.6 Define background screens.

.7 Define connecting lines and curves.

.8 Locate, orient, and size descriptive text.

.9 Define and display colours of elements.

.10 Establish co-relation between symbols or text and associated system points or other graphic displays.

.5 User to be able to build graphic displays showing on-line point data from multiple MCU panels. Graphic displays to represent logical grouping of system points or calculated data based upon building function, mechanical system, building layout, other logical grouping of points which aids operator in analysis of facility operation. Data to be refreshed on screen as "changed data" without redrawing of entire screen or row on screen.

.6 Dynamic data (temperature, humidity, flow, status) to be shown in actual schematic locations, to be automatically updated to show current values without operator intervention.

.7 Windowing environment to allow user to view several graphics simultaneously to permit analysis of building operation, system performance, display of graphic associated with alarm to be viewed without interrupting work in progress. If interface is unable to display several different types of display at same time, provide at minimum 2OWS's.

.8 Utilize graphics package to generate system schematic diagrams as required in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation, and as directed by HRCE Representative. In addition provide graphics for schematic depicted on mechanical plan flow diagrams, point lists, and system graphics. Provide graphic for floor depicting room sensors and control devices located in their actual location. For floor graphic include secondary diagram to show TCU-VAV box actuator and, flow sensor. Diagram to be single line schematic of ductwork as well as associated heating coil or radiation valve. HRCE Representative to provide CAD floor layouts. Provide display of TCU-VAV's in table form, include following values as minimum; space temp, setpoint, mode, actual flow, min flow setpoint, max flow setpoint, cooling signal value, and heating signal value. Organize table by rooms and floor groupings.

.9 Provide complete directory of system graphics, including other pertinent system information. Utilize mouse or pointing device to "point and click" to activate selected graphic.

.10 Provide unique sequence of operation graphic or pop-up window for each graphic that is depicted on OWS. Provide access to sequence of operation graphic by link button on each system graphic. Provide translation of sequence of operation, a concise explanation of systems operation, from control descriptive logic into plain English language.

.13 Event/Alarm Module: displays in window alarms as received and stored in General Event Log:

.1 Classify alarms as "critical", "cautionary", "maintenance". Alarms and alarm classifications to be designated by personnel requiring password level.

.2 Presentation of alarms to include features identified under applicable report definitions of Report Module paragraph.

.3 Alarm reports:

.1 Summary of points in critical, cautionary or maintenance alarm. Include at least point name, alarm type, current value, and limit exceeded.

.2 Analog alarm limit summary: include point name, alarm limits, and deviation limits.

.3 Summary of alarm messages: include associated point name, and alarm description.

.4 Software to notify operator of each occurrence of alarm conditions. Each point to have its own secondary alarm message.

.5 EMCS to notify operator of occurrence of alarms originating at site device within following time periods of detection:

.1 Critical - 5 seconds.

.2 Cautionary - 10 seconds.

.3 Maintenance - 10 seconds.

.6 Display alarm messages in English.

.7 Primary alarm message to include as minimum: point identifier, alarm classification, time of occurrence, type of alarm. Provide for initial message to be automatically presented to operator whenever associated alarm is reported. Assignment of secondary messages to point to be operator-editable function. Provide secondary messages giving further information (telephone lists, maintenance functions) on per point basis.

.8 System reaction to alarms: provide alarm annunciation by dedicated window (activated to foreground on receipt of new alarm or event) of OWS with visual and audible hardware indication. Acknowledgement of alarm to change visual indicator from flashing to steady state and to silence audible device. Acknowledgment of alarm to be time, date and operator stamped and stored in General Event Log. Steady state visual indicator to remain until alarm condition is corrected but must not impede reporting of new alarm conditions. Notification of alarm not to impede notification of subsequent alarms or function of Controller's/CDL. Do not allow random occurrence of alarms to cause loss of alarm or over-burden system. Do not allow acknowledgement of one alarm as acknowledgement of other alarms.

.9 Controller network alarms: system supervision of controllers and communications lines to provide following alarms as minimum:

.1 Controller not responding - where possible delineate between controller and communication line failure.

.2 Controller responding - return to normal.

.3 Controller communications bad - high error rate or loss of communication.

.4 Controller communications normal - return to normal.

.10 Digital alarm status to be interrogated every 2 seconds as minimum or be direct interrupting non-polling type (COV). Annunciate each non-expected status with alarm message.

.14 Archiving and Restoration Module:

.1 Primary OWS to include services to store back-up copies of controller databases. Perform complete backup of OWS software and data files at time of system

installation and at time of final acceptance. Provide backup copies before and after Controller's revisions or major modifications.

.2 Provide continuous integrity supervision of controller data bases. When controller encounters database integrity problems with its data base, system to notify operator of need to download copy data base to restore proper operation.

.3 Ensure data base back-up and downloading occurs over LAN without specialized operator technical knowledge. Provide operator with ability to manually download entire controller data base or parts thereof as required.

.15 CDL Generator and Modifier Module:

.1 CDL Generator module to permit generation and modification of CDLs.

.2 Provide standard reference modules for text based systems module that will permit modification to suit site specific applications. Module to include cut, paste, search, and compare utilities to permit easy CDL modification and verification.

.3 Provide full library of symbols used by manufacturer for system product installed accessible to operators for systems using graphical environment for creation of CDLs Module to include graphic tools required to generate and create new object code for downloading to building controllers.

.4 Module to permit testing of code before downloading to building controllers.

2.6 ADDITIONAL UTILITY SOFTWARE

.1 Supply and install on primary OWS, following CAD software products by Autodesk Inc. and include:

.1 AutoCAD LT Latest Version.

.2 Include special drivers, fonts, to ensure complete and proper functioning of software packages specified. Deliver system complete with full set of User Manuals.

.3 Enter soft copy submissions, including "Record" drawings specified in Section 25 05 03 - EMCS: Project Record Documents in OWS.

.4 Enter soft copy of Architectural, Electrical, Mechanical systems plans, and "Record" drawings in OWS. Plans and drawings to be provided by HRCE Representative.

Part 3 Execution

3.1 INSTALLATION REQUIREMENTS

.1 Provide necessary power as required from local 120 V emergency power branch circuit panels for OWS's and peripheral equipment:

.1 Install tamper locks on breakers of circuit panels.

.2 Refer to UPS requirements stated under OWS Hardware in PART 2.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE):

.1 ASHRAE 2003, Applications Handbook, SI Edition.

.2 CSA Group (CSA):

.1 C22.2 No.205-M1983 (R1999), Signal Equipment.

.3 Institute of Electrical and Electronics Engineers (IEEE):

.1 IEEE C37.90.1-02, Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.

1.2 DEFINITIONS

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

1.3 DESCRIPTION

.1 General: Network of controllers comprising of MCU('s), LCU('s), ECU('s), or TCU('s) to be provided as indicated in System Architecture Diagram to support building systems and associated sequence(s) of operations as detailed in these specifications:

.1 Provide sufficient controllers to meet intents and requirements of this section.

.2 Controller quantity and point contents to be approved by HRCE Representative at time of preliminary design review.

.2 Controllers: stand-alone intelligent Control Units:

.1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.

.2 Incorporate communication interface ports for communication to LANs to exchange information with other Controllers.

.3 Capable of interfacing with operator interface device.

.4 Execute its logic and control using primary inputs and outputs connected directly to its onboard input/output field terminations or slave devices, and without need to interact with other controller. Secondary input used for reset such as outdoor air temperature may be located in other Controller(s):

.1 Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).

.3 Interface to include provisions for ethernet high speed internet connection with EMCS for remote monitoring and control:

.1 Controller to include integral built-in web-server software with encryption to facilitate secure remote login without requiring standalone OWS. Use of OWS remote desktop software is not an accepted solution for remote login.

1.4 DESIGN REQUIREMENTS

.1 To include:

.1 Scanning of AI and DI connected inputs for detection of change of value and processing detection of alarm conditions.

.2 Perform On-Off digital control of connected points, including resulting required states generated through programmable logic output.

.3 Perform Analog control using programmable logic (including PID) with adjustable dead bands and deviation alarms.

.4 Control of systems as described in sequence of operations.

.5 Execution of optimization routines as listed in this section.

.2 Total spare capacity for MCUs and LCUs: at least 25% of each point type distributed throughout the MCUs and LCUs.

.3 Field Termination and Interface Devices:

.1 To: CSA C22.2 No. 205.

.2 Electronically interface sensors and control devices to processor unit.

.3 Include, but not be limited to, following:

.1 Programmed firmware or logic circuits to meet functional and technical requirements.

.2 Power supplies for operation of logics devices and associated field equipment.

.3 Lockable wall cabinet.

.4 Required communications equipment and wiring (if remote units).

.5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.

.6 Input Output interface to accept as minimum AI, AO, DI, DO functions as specified.

.7 Wiring terminations: use conveniently located screw type or spade lug terminals.

.4 AI interface equipment to:

.1 Convert analog signals to digital format with 10 bit analog-to-digital resolution.

.2 Provide for following input signal types and ranges:

.1 4 - 20 mA;

.2 0 - 10 V DC;

.3 100/1,000 ohm RTD input;

.3 Meet IEEE C37.90.1 surge withstand capability.

.4 Have common mode signal rejection greater than 60 dB to 60 Hz.

.5 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.

.5 AO interface equipment:

.1 Convert digital data from controller processor to acceptable analog output signals using 8 bit digital-to-analog resolution.

.2 Provide for following output signal types and ranges:

.1 4 - 20 mA.

.2 0 - 10 V DC.

.3 Meet IEEE C37.90.1 surge withstand capability.

.6 DI interface equipment:

.1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.

.2 Meet IEEE C37.90.1 surge withstand capability.

.3 Accept pulsed inputs up to 2 kHz.

.7 DO interface equipment:

.1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to 0.5 amps at 24 V AC.

.2 Switch up to 5 amps at 220 V AC using optional interface relay.

.4 Controllers and associated hardware and software: operate in conditions of 0 °C to 44 °C and 20% to 90% non-condensing RH.

.5 Controllers (MCU, LCU): mount in wall mounted cabinet with hinged, keyed-alike locked door:

.1 Provide for conduit entrance from top, bottom or sides of panel.

.2 ECUs and TCUs to be mounted in equipment enclosures or separate enclosures.

.3 Mounting details as approved by HRCE Representative for ceiling mounting.

.6 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.

.7 Provide surge and low voltage protection for interconnecting wiring connections.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures:

.1 Submit product data sheets for each product item proposed for this project.

Part 2 Products

2.1 MASTER CONTROL UNIT (MCU)

.1 General: primary function of MCU is to provide co-ordination and supervision of subordinate devices in execution of optimization routines such as demand limiting or enthalpy control.

.2 Include high speed communication LAN Port for Peer to Peer communications with OT(s) and other MCU level devices:

.1 MCU must support BACnet.

.3 MCU local I/O capacity as follows:

.1 MCU I/O points as allocated in I/O Summary Table referenced in MD13800.

.2 LCUs may be added to support system functions.

.4 Central Processing Unit (CPU):

.1 Processor to consist of minimum 16 bit microprocessor capable of supporting software to meet specified requirements.

.2 CPU idle time to be more than 30% when system configured to maximum input and output with worst case program use.

.3 Minimum addressable memory to be at manufacturer's discretion but to support at least performance and technical specifications to include but not limited to:

.1 Non-volatile EEPROM to contain operating system, executive, application, sub-routine, other configurations definition software. Tape media not acceptable.

.2 Battery backed (72 hour minimum capacity) RAM (to reduce the need to reload operating data in event of power failure) to contain CDLs, application parameters, operating data or software that is required to be modifiable from operational standpoint such as schedules, setpoints, alarm limits, PID constants, and CDL and hence modifiable on-line through operator panel or remote operator's interface.

.4 Include uninterruptible clock accurate to plus or minus 5 secs/month, capable of deriving year/month/day/hour/minute/second, with rechargeable batteries for minimum 72 hour operation in event of power failure.

.5 Local Operator Terminal (OT): Provide OT for each MCU unless otherwise indicated:

.1 Mount access/display panel in MCU or in suitable enclosure beside MCU as approved by HRCE Representative.

.2 Support operator's terminal for local command entry, instantaneous and historical data display, programs, additions, and modifications.

.3 Display simultaneously minimum of 16 point identifiers to allow operator to view single screen dynamic displays depicting entire mechanical systems. Point identifiers to be in English.

.4 Functions to include, but not be limited to, following:

.1 Start and stop points.

.2 Modify setpoints.

.3 Modify PID loop parameters.

.4 Override PID control.

.5 Change time/date.

.6 Add/modify/start/stop weekly scheduling.

.7 Add/modify setpoint weekly scheduling.

.8 Enter temporary override schedules.

.9 Define holiday schedules.

.10 View analog limits.

.11 Enter/modify analog warning limits.

.12 Enter/modify analog alarm limits.

.13 Enter/modify analog differentials.

.5 Provide access to real and calculated points in controller to which it is connected or to other controller in network. This capability not to be restricted to subset of predefined "global points" but to provide totally open exchange of data between OT and other controller in network.

.6 Operator access to OTs: via username and password. Password changes to automatically be downloaded to controllers on network.

.7 Provide prompting to eliminate need for user to remember command format or point names. Prompting to be consistent with user's password clearance and types of points displayed to eliminate possibility of operator error.

.8 Identity of real or calculated points to be consistent with network devices.

2.2 LOCAL CONTROL UNIT (LCU)

.1 Provide multiple control functions for typical built-up and package HVAC systems, hydronic systems, and electrical systems.

.2 Minimum of 16 I/O points of which minimum be 4 AOs, 4 AIs, 4 DIs, 4 DOs.

.3 Points integral to one Building System to be resident on only one controller.

.4 Microprocessor capable of supporting necessary software and hardware to meet specified requirements as listed in previous MCU article with following additions:

.1 Include minimum 2 interface ports for connection of local computer terminal.

.2 Design so that shorts, opens, or grounds on input or output will not interfere with other input or output signals.

.3 Physically separate line voltage (70 V and over) circuits from DC logic circuits to permit maintenance on either circuit with minimum hazards to technician and equipment.

.4 Include power supplies for operation of LCU and associated field equipment.

.5 In event of loss of communications with, or failure of, MCU, LCU to continue to perform control. Controllers that use defaults or fail to open or close positions not acceptable.

.6 Provide conveniently located screw type or spade lug terminals for field wiring.

2.3 TERMINAL/EQUIPMENT CONTROL UNIT (TCU/ECU)

.1 Microprocessor capable of supporting necessary software and hardware to meet TCU/ECU functional specifications:

.1 TCU/ECU definition to be consistent with those defined in ASHRAE HVAC Applications Handbook Section 45.

.2 Controller to communicate directly with EMCS through EMCS LAN and provide access from EMCS OT for setting occupied and unoccupied space temperature setpoints, flow setpoints, and associated alarm values, permit reading of sensor values, field control values (% open) and transmit alarm conditions to EMCS OT.

.3 VAV Terminal Controller:

.1 Microprocessor based controller with integral flow transducer, including software routines to execute PID algorithms, calculate airflow for integral flow transducer and measure temperatures as per I/O Summary required inputs. Sequence of operation to ASHRAE HVAC Applications Handbook.

.2 Controller to support point definition; in accordance with Section 25 05 01 - EMCS: General Requirements.

.3 Controller to operate independent of network in case of communication failure.

.4 Controller to include damper actuator and terminations for input and output sensors and devices.

2.4 SOFTWARE

.1 General:

.1 Include as minimum: operating system executive, communications, application programs, operator interface, and systems sequence of operation - CDL's.

.2 Include "firmware" or instructions which are programmed into ROM, EPROM, EEPROM or other non-volatile memory.

.3 Include initial programming of Controllers, for entire system.

.2 Program and data storage:

.1 Store executive programs and site configuration data in ROM, EEPROM, or other non-volatile memory.

.2 Maintain CDL and operating data including setpoints, operating constants, alarm limits in battery-backed RAM, or EEPROM for display and modification by operator.

.3 Programming languages:

.1 Program Control Description Logic software (CDL) using English like or graphical, high level, general control language.

.2 Structure software in modular fashion to permit simple restructuring of program modules if future software additions or modifications are required. Go to constructs not allowed unless approved by HRCE Representative.

.4 Operator Terminal interface:

.1 Operating and control functions include:

.1 Multi-level password access protection to allow user/manager to limit workstation control.

.2 Alarm management: processing and messages.

.3 Operator commands.

.4 Reports.

.5 Displays.

.6 Point identification.

.5 Pseudo or calculated points:

.1 Software to provide access to value or status in controller or other networked controller in order to define and calculate pseudo point. When current pseudo point value is derived, normal alarm checks must be performed or value used to totalize.

.2 Inputs and outputs for process: include data from controllers to permit development of network-wide control strategies. Processes also to permit

operator to use results of one process as input to number of other processes (e.g. cascading).

.6 Control Description Logic (CDL):

.1 Capable of generating on-line project-specific CDLs which are software based, programmed into RAM or EEPROM and backed up to central control station. Owner must have access to these algorithms for modification or to be able to create new ones and to integrate these into CDLs on BC(s) remotely from central control station.

.2 Write CDL in high level language that allows algorithms and interlocking programs to be written simply and clearly. Use parameters entered into system (e.g. setpoints) to determine operation of algorithm. Operator to be able to alter operating parameters on-line from central control station and BC(s) to tune control loops.

.3 Perform changes to CDL on-line.

.4 Control logic to have access to values or status of points available to controller including global or common values, allowing cascading or inter-locking control.

.5 Energy optimization routines including enthalpy control, supply temperature reset, to be LCU or MCU resident functions and form part of CDL.

.6 MCU to be able to perform following pre-tested control algorithms:

.1 Two position control.

.2 Proportional Integral and Derivative (PID) control.

.7 Control software to provide ability to define time between successive starts for each piece of equipment to reduce cycling of motors.

.8 Provide protection against excessive electrical-demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

.9 Power Fail Restart: upon detection of power failure system to verify availability of Emergency Power as determined by emergency power transfer switches and analyze controlled equipment to determine its appropriate status under Emergency power conditions and start or stop equipment as defined by I/O Summary. Upon resumption of normal power as determined by emergency power transfer switches, MCU to analyze status of controlled equipment, compare with normal occupancy scheduling, turn equipment on or off as necessary to resume normal operation.

.7 Event and Alarm management: use management by exception concept for Alarm Reporting. This is system wide requirement. This approach will ensure that only principal alarms are reported to OT and central control station. Events which occur as direct result of primary event to be suppressed by system and only events which fail to occur to be reported. Such event sequence to be identified in I/O Summary and sequence of operation. Examples of above are, operational temperature alarms limits which are exceeded when main air handler is stopped, or General Fire condition shuts air handlers down, only Fire alarm status shall be reported. Exception is, when air handler which is supposed to stop or start fails to do so under event condition.

.8 Energy management programs: include specific summarizing reports, with date stamp indicating sensor details which activated and or terminated feature:

.1 MCU in coordination with subordinate LCU, TCU, ECU to provide for the following energy management routines:

.1 Time of day scheduling.

.2 Calendar based scheduling.

.3 Holiday scheduling.

.4 Temporary schedule overrides.

.5 Optimal start stop.

.6 Night setback control.

.7 Enthalpy (economizer) switchover.

.8 Peak demand limiting.

.9 Temperature compensated load rolling.

.10 Fan speed/flow rate control.

.11 Hot water reset.

.12 Geothermal water reset.

.13 Boiler sequencing.

.14 Heat Pump Sequencing

.15 Night purge.

.2 Programs to be executed automatically without need for operator intervention and be flexible enough to allow customization.

.3 Apply programs to equipment and systems as specified or requested by the HRCE Representative.

.9 Function/Event Totalization: features to provide predefined reports which show daily, weekly, and monthly accumulating totals and which include high rate (time stamped) and low rate (time stamped) and accumulation to date for month:

.1 MCUs to accumulate and store automatically run-time for binary input and output points.

.2 MCU to automatically sample, calculate and store consumption totals on daily, weekly or monthly basis for user-selected analog or binary pulse input-type points.

.3 MCU to automatically count events (number of times pump is cycled off and on) daily, weekly, or monthly basis.

.4 Totalization routine to have sampling resolution of 1 min or less for analog inputs.

.5 Totalization to provide calculations and storage of accumulations up to 99,999.9 units (e.g. kWH, litres, tonnes, etc.).

.6 Store event totalization records with minimum of 9,999,999 events before reset.

.7 User to be able to define warning limit and generate user-specified messages when limit reached.

2.5 LEVELS OF ADDRESS

.1 Upon operator's request, EMCS to present status of any single 'point', 'system' or point group, entire 'area', or entire network on printer or remotely at central control station as selected by operator:

.1 Display analog values digitally to 1 place of decimals with negative sign as required.

.2 Update displayed analog values and status when new values received.

.3 Flag points in alarm by blinking, reverse video, different colour, bracketed, or other means to differentiate from points not in alarm.

.4 Updates to be change-of-value (COV)-driven or if polled not exceeding 2 second intervals.

2.6 POINT NAME SUPPORT

.1 Controllers (MCU, LCU) to support PWGSC point naming convention as defined in Section 25 05 01 - EMCS: General Requirements.

Part 3 Execution

3.1 LOCATION

.1 Location of Controllers to be approved by HRCE Representative.

3.2 INSTALLATION

.1 Install Controllers in secure locking enclosures as directed by HRCE Representative.

.2 Provide necessary power from local 120 V branch circuit panel for equipment.

.3 Install tamper locks on breakers of circuit breaker panel.

.4 Use Uninterruptible Power Supply (UPS) and emergency power when equipment must operate in emergency and co-ordinating mode.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI):

.1 ANSI C12.7-1993 (R1999), Requirements for Watthour Meter Sockets.

.2 ANSI/IEEE C57.13-1993, Standard Requirements for Instrument Transformers.

.2 ASTM International (ASTM):

.1 ASTM B148-97 (03), Standard Specification for Aluminum-Bronze Sand Castings.

.3 National Electrical Manufacturer's Association (NEMA):

.1 NEMA 250-03, Enclosures for Electrical Equipment (1,000 Volts Maximum).

.4 Air Movement and Control Association, Inc. (AMCA):

.1 AMCA Standard 500-D-98, Laboratory Method of Testing Dampers For Rating.

.5 CSA Group (CSA):

.1 CSA-C22.1-02, Canadian Electrical Code, Part 1 (19th Edition), Safety Standard for Electrical Installations.

.6 Green Building Initiative (GBI):

.1 Green Globes Design for New Construction and Major Renovations, Version 2. Green Globes for New Construction Technical Manual 2015.

1.2 DEFINITIONS

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

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 01 33 00 - Submittal Procedures.

.2 Pre-Installation Tests:

.1 Submit samples at random from equipment shipped, as requested by HRCE Representative, for testing before installation. Replace devices not meeting specified performance and accuracy.

.3 Manufacturer's Instructions:

.1 Submit manufacturer's installation instructions for specified equipment and devices.

1.4 EXISTING CONDITIONS

.1 Repair surfaces damaged during execution of Work.

Part 2 Products

2.1 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 not exceed Noise Criteria (NC) of 25. Noise generated by any device must not be detectable above space ambient conditions.

.9 Range: including temperature, humidity, and pressure as indicated

2.2 TEMPERATURE SENSORS

.1 General: except for room sensors to be resistance or thermocouple type to following requirements:

.1 Thermocouples: limit to temperature range of 200 °C and over.

.2 RTD's: 100 or 1,000 ohm at 0 °C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored leadwires. Coefficient of resistivity: 0.00385 ohms/ohm °C.

.3 Sensing element: hermetically sealed.

.4 Stem and tip construction: copper or type 304 stainless steel.

.5 Time constant response: less than 3 seconds to temperature change of 10 °C.

.6 Immersion wells: NPS 3/4, stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length 100 150 mm as indicated.

.2 Duct temperature sensors:

.1 General purpose duct type: suitable for insertion into ducts at various orientations, insertion length 460 mm as indicated.

.2 Averaging duct type: incorporates numerous sensors inside assembly which are averaged to provide one reading. Minimum insertion length 6,096 mm. Bend probe at field installation time to 100 mm radius at point along probe without degradation of performance.

.3 Outdoor air temperature sensors:

.1 Outside air type: complete with probe length 100 - 150 mm long, non-corroding shield to minimize solar and wind effects, threaded fitting for mating to 13 mm conduit, weatherproof construction in NEMA 4 enclosure.

2.3 TEMPERATURE TRANSMITTERS

.1 Requirements:

- .1 Input circuit: to accept 3-lead, 100 or 1,000 ohm at 0 °C, platinum resistance detector type sensors.
- .2 Power supply: 24 V DC into load of 575 ohms. Power supply effect less than 0.01 °C per volt change.
- .3 Output signal: 4 - 20 mA into 500 ohm maximum load.
- .4 Input and output short circuit and open circuit protection.
- .5 Output variation: less than 0.2% of full scale for supply voltage variation of plus or minus 10%.
- .6 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 0.5% of full scale output.
- .7 Maximum current to 100 or 1,000 ohm RTD sensor: not to exceed 25 mA.
- .8 Integral zero and span adjustments.
- .9 Temperature effects: not to exceed plus or minus 1.0% of full scale/50 °C.
- .10 Long term output drift: not to exceed 0.25% of full scale/6 months.
- .11 Transmitter ranges: select narrowest range to suit application from following:
  - .1 Minus 50 °C to plus 50 °C, plus or minus 0.5 °C.
  - .2 0 to 100 °C, plus or minus 0.5 °C.
  - .3 0 to 50 °C, plus or minus 0.25 °C.
  - .4 0 to 25 °C, plus or minus 0.1 °C.
  - .5 10 to 35 °C, plus or minus 0.25 °C.

2.4 SOLID STATE RELAYS

.1 General:

- .1 Relays to be socket or rail mounted.
- .2 Relays to have LED Indicator
- .3 Input and output Barrier Strips to accept 14 to 28 AWG wire.
- .4 Operating temperature range to be -20 °C to 70 °C.
- .5 Relays to be CSA Certified.
- .6 Input/output Isolation Voltage to be 4,000 VAC at 25 °C for 1 second maximum duration.
- .7 Operational frequency range, 45 to 65 HZ.

.2 Input:

- .1 Control voltage, 3 to 32 VDC.
- .2 Drop out voltage, 1.2 VDC.
- .3 Maximum input current to match AO (Analog Output) board.

.3 Output:

- .1 AC or DC Output Model to suit application.

2.5 CURRENT SENSING RELAYS

.1 Requirements:

- .1 Suitable to detect belt loss or motor failure.
- .2 Trip point adjustment, output status LED.
- .3 Split core for easy mounting.
- .4 Induced sensor power.
- .5 Relay contacts: capable of handling 0.5 amps at 30 VAC/DC. Output to be NO solid state.
- .6 Suitable for single or 3 phase monitoring. For 3-Phase applications: provide for discrimination between phases.
- .7 Adjustable latch level.

2.6 CONTROL DAMPERS

.1 Construction: blades, 152 mm wide, 1,219 mm long, maximum. Modular maximum size, 1,219 mm wide x 1,219 mm high. Three or more sections to be operated by jack shafts.

.2 Materials:

- .1 Frame: 2.03 mm minimum thickness extruded aluminum. For outdoor air and exhaust air applications, frames to be insulated.
- .2 Blades: extruded aluminum. For outdoor air/exhaust air applications, blades to be internally insulated.
- .3 Bearings: maintenance free, synthetic type of material.
- .4 Linkage and shafts: aluminum, zinc and nickel plated steel.
- .5 Seals: synthetic type, mechanically locked into blade edges:
  - .1 Frame seals: synthetic type, mechanically locked into frame sides.

.3 Performance: minimum damper leakage meet or exceed AMCA Standard 500-D ratings:

- .1 Size/Capacity: refer to damper schedule
- .2 25 L/s/m^2 maximum allowable leakage against 1,000 Pa static pressure for outdoor air and exhaust air applications.
- .3 Temperature range: minus 40 °C to plus 100 °C.

.4 Arrangements: dampers mixing warm and cold air to be parallel blade, mounted at right angles to each other, with blades opening to mix air stream.

.5 Jack shafts:

- .1 25 mm diameter solid shaft, constructed of corrosion resistant metal complete with required number of pillow block bearings to support jack shaft and operate dampers throughout their range.
- .2 Include corrosion resistant connecting hardware to accommodate connection to damper actuating device.
- .3 Install using manufacturer's installation guidelines.
- .4 Use same manufacturer as damper sections.

2.7 ELECTRONIC CONTROL DAMPER ACTUATORS

.1 Requirements:

- .1 Direct mount proportional type as indicated.
- .2 Spring return for "fail-safe" in Normally Open or Normally Closed position as indicated.
- .3 Operator: size to control dampers against maximum pressure and dynamic closing/opening pressure, whichever is greater.
- .4 Power requirements: 5 VA maximum at 24 V AC.
- .5 Operating range: 0 - 10 V DC or 4 - 20 mA DC.
- .6 For VAV box applications floating control type actuators may be used.
- .7 Damper actuator to drive damper from full open to full closed in less than 120 seconds.

2.8 CONTROL VALVES

.1 Body: globe style, characterized ball:

- .1 Flow characteristic as indicated on control valve schedule: equal percentage, linear, quick opening.
- .2 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.
- .3 Normally open Normally closed, as indicated.
- .4 Three Two port, as indicated.
- .5 Leakage rate ANSI class IV, 0.01% of full open valve capacity.
- .6 Packing easily replaceable.
- .7 Stem, stainless steel.
- .8 Plug and seat, stainless steel, brass, bronze.
- .9 Disc, replaceable, material to suit application.
- .10 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.
- .11 NPS 2½ and larger:
  - .1 Flanged connections.
  - .2 Valves to ANSI Class 150 or 250 as indicated, valves to bear ANSI mark.
  - .3 Rangeability 100:1 minimum.

.2 Butterfly Valves NPS 2 and larger:

- .1 Body: for chilled water ANSI Class 150 cast iron lugged body wafer body installed in locations as indicated. For steam and heating water ANSI Class 150 carbon steel wafer body lugged body.
- .2 End connections to suit flanges that are ANSI Class 150.
- .3 Extended stem neck to provide adequate clearance for flanges and insulation.

.4 Pressure limit: bubble tight sealing to 170 kilopascals.

.5 Disc/vane: 316 stainless steel, aluminum bronze to ASTM B148.

.6 Seat: for service on chilled water PTFE (polytetrafluoroethylene), EPDM (ethylene propylene diene monomer). For service on steam and heating water PTFE, RTFE (reinforced PTFE).

.7 Stem: 316 stainless steel.

.8 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.

.9 Flow characteristic linear.

.10 Maximum flow requirement as indicated on control valve schedule.

.11 Maximum pressure drop as indicated on control valve schedule: pressure drop not to exceed one half of inlet pressure.

.12 Normally closed Normally open, as indicated.

.13 Valves are to be provided complete with mounting plate for installation of actuators.

2.9 ELECTRONIC/ELECTRIC VALVE ACTUATORS

.1 Requirements:

.1 Construction: steel, cast iron, and aluminum.

.2 Control signal: 4-20 mA DC or 0-10 V DC.

.3 Positioning time: to suit application. 90 sec maximum.

.4 Fail to normal position as indicated.

.5 Scale or dial indication of actual control valve position.

.6 Size actuator to meet requirements and performance of control valve specifications.

.7 For interior and perimeter terminal heating and cooling applications floating control actuators are acceptable.

.8 Minimum shut-off pressure: refer to control valve schedule.

2.10 PANELS

.1 Wall mounted enamelled steel cabinets with hinged and key-locked front door.

.2 Multiple panels as indicated required to handle requirements with additional space to accommodate 25% additional capacity as required HRCE Representative without adding additional cabinets.

.3 Panels to be lockable with same key.

Part 3 Execution

3.1 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 Temperature transmitters, humidity transmitters, current-to-pneumatic transducers, solenoid air valves, controllers, relays: install in NEMA I enclosure or as required for specific applications. Provide for electrolytic isolation in cases when dissimilar metals make contact.

.4 Support field-mounted panels, transmitters, and sensors on pipe stands or channel brackets.

.5 Fire stopping: provide space for fire stopping. Maintain the fire-resistance rating integrity of the fire separation.

.6 Electrical:

.1 Complete installation in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.

.3 Refer to electrical control schematics included as part of control design schematics on drawings.

.4 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.

.5 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 conduit fill not to exceed 40%.

.4 Design drawings do not show conduit layout.

.6 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. HRCE Representative to review before starting Work. Wiring in mechanical rooms, wiring in service rooms, and exposed wiring must be in conduit.

.7 Mechanical: supply and install:

.1 Pipe Taps.

.2 Wells and Control Valves.

.3 Air flow stations, dampers, and other devices.

.8 VAV Terminal Units: supply, install, and adjust as required:

.1 Air probe, actuator, and associated vav controls.

.2 Tubing from air probe to dp sensor as well as installation and adjustment of air flow sensors and actuators.

.3 Co-ordinate air flow adjustments with balancing trade.

3.2 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 Outdoor installation:

.1 Protect from solar radiation and wind effects by non-corroding shields.

.2 Install in NEMA 4 enclosures.

.4 Duct installations:

.1 Do not mount in dead air space.

.2 Locate within sensor vibration and velocity limits.

.3 Securely mount extended surface sensor used to sense average temperature.

.4 Thermally isolate elements from brackets and supports to respond to air temperature only.

.5 Support sensor element separately from coils, filter racks.

.5 Averaging duct type temperature sensors:

.1 Install averaging element horizontally across the ductwork starting 305 mm from top of ductwork. Each additional horizontal run to be no more than 305 mm from one above it. Continue until complete cross sectional area of ductwork is covered. Use multiple sensors where single sensor does not meet required coverage.

.2 Wire multiple sensors in series for low temperature protection applications.

.3 Wire multiple sensors separately for temperature measurement.

.4 Use software averaging algorithm to derive overall average for control purposes.

.6 Thermowells: install for piping installations:

.1 Locate well in elbow where pipe diameter is less than well insertion length.

.2 Thermowell to restrict flow by less than 30%.

.3 Use thermal conducting paste inside wells.

3.3 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.

3.4 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES AND SENSORS

.1 Install isolation valve and snubber on sensors between sensor and pressure source where code allows:

.1 Protect sensing elements on steam and high temperature hot water service with pigtail syphon between valve and sensor.

3.5 IDENTIFICATION

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

3.6 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.

END OF SECTION

Part 1 General

1.1 SEQUENCING

.1 Sequence of operations for systems are presented on the project drawings.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 CSA Group:

.1 CSA C22.1-24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.

.2 CSA C235-19, Preferred Voltage Levels for AC Systems up to 50 000 V.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit necessary number of drawings and specifications for review and approval to Authority Having Jurisdiction prior to commencement of work. Pay all associated fees.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature, and data sheets for review and include product characteristics, performance criteria, physical size, finish, and limitations.

.3 Shop drawings:

.1 Submit manufacturer shop drawings of all products and equipment in PDF format, legible, and clear:

.1 A cover sheet is to be incorporated into each PDF submission and indicate the project name and number, specification section number and name, the Contractor’s name, supplier’s name, date submitted, Contractor’s stamp, and signature identifying that the Contractor has reviewed the information prior to submission for correctness and completeness. Sufficient white space (minimum of ¼ page) is to be left for the Engineer-Architect’s stamp and comments.

.2 Part numbers for products and equipment to be clearly identifies with all required accessories and components indicated.

.3 Submit drawings stamped and signed by professional engineer registered or licensed in Nova Scotia, Canada.

.4 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.

.5 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.

.6 Indicate of drawings clearances for operation, maintenance, and replacement of operating equipment devices.

.7 If changes are required, resubmit corrected shop drawings as many times as necessary at no additional cost.

.8 If changes are required, notify HRCE Representative of these changes before they are made.

.4 Certificates:

.1 Provide CSA certified equipment and material.

.2 Where CSA certified equipment and material is not available, submit such equipment and material to Authority Having Jurisdiction for special approval before delivery to site.

.3 Submit test results of installed electrical systems and instrumentation.

.4 Permits and fees: in accordance with General Conditions of contract.

.5 Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.

.6 Submit, upon completion of Work, load balance report as described in PART 3 - FIELD QUALITY CONTROL.

.7 Submit certificate of acceptance from Authority Having Jurisdiction upon completion of Work to HRCE Representative.

.5 Manufacturer's Field Reports: submit to HRCE Representative 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.

.6 Submit documentation and data for commissioning in accordance with Section 01 91 13 - General Commissioning Requirements.

1.3 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 Print or engrave operating instructions and frame under glass or in approved laminated plastic.

.4 Post instructions where directed.

.5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.

.6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 DESIGN REQUIREMENTS

.1 Operating voltages: to CAN3-C235.

.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard:

.1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

.3 Language operating requirements: provide identification nameplates and labels for control items in English.

2.2 MATERIALS AND EQUIPMENT

.1 Material and equipment to be CSA certified. Where CSA certified material and equipment is not available, obtain special approval from Authority Having Jurisdiction 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, and screws used for termination of wiring are suitable for either copper or aluminum conductors.

2.6 EQUIPMENT IDENTIFICATION

.1 Identify electrical equipment with nameplates and labels as follows:

.1 Nameplates: Lamicoid 3 mm thick plastic engraving sheet, white face, black core, lettering accurately aligned and engraved into core.

.2 Sizes as follows:

NAMEPLATE SIZES			
Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

.2 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.

.3 Wording on nameplates to be approved by HRCE Representative prior to manufacture.

.4 Allow for minimum of twenty-five (25) letters per nameplate.

.5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

.6 Disconnects: indicate switch designation (name), ampacity, fuse rating (if applicable), voltage, number of poles, and source.

.7 Starters and contactors: indicate equipment being controlled, ampacity, horsepower, or power rating, and voltage.

.8 Panelboards: Indicate panel designation (name), ampacity, voltage, number of phases, number of wires, and source.

.9 Terminal cabinets and pull boxes: indicate source, system and voltage.

.10 Transformers: indicate transformer designation (name), capacity in kVA, primary and secondary voltages, and source.

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.

.2 Maintain phase sequence and colour coding throughout.

.3 Colour coding: to CSA C22.1.

.4 Use colour coded wires in communication cables, matched throughout system.

2.8 CONDUIT AND CABLE IDENTIFICATION

.1 Colour code conduits, boxes and metallic sheathed cables.

.2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.

.3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

Type	Prime	Auxiliary
up to 250 V	Yellow	
up to 600 V	Yellow	Green
up to 5 kV	Yellow	Blue
up to 15 kV	Yellow	Red
Telephone	Green	
Other Communication Systems	Green	Blue
Fire Alarm	Red	
Emergency Voice	Red	Blue
Other Security Systems	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.

Part 3 Execution

3.1 INSTALLATION

.1 Do complete installation in accordance with CSA C22.1 and AHJ requirements.

.2 Do underground systems in accordance with CSA-C22.3 No. 7 and AHJ requirements.

3.2 FIRE STOPPING

.1 Fire stopping and smoke seal materials around cable, conduit, and tray openings and inside of conduit, tray, device boxes, and sleeve penetrations as required to maintain firestop system rating.

.2 Installation of fire-stopping and smoke seal materials and components to be in accordance with ULC/cUL certification and manufacturer’s instructions.

3.3 NAMEPLATES AND LABELS

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

3.4 CONDUIT AND CABLE INSTALLATION

.1 Install conduit and sleeves prior to pouring of concrete:

.1 Sleeves through concrete: plastic, sized for free passage of conduit, and protruding 50 mm.

.2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.

.3 Install cables, conduits, and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

3.5 LOCATION OF OUTLETS

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

.2 Change location of outlets at no extra cost or credit, providing distance does not exceed 3,000 mm and information is given before installation.

.3 Locate light switches on latch side of doors:

.1 Locate disconnect devices in mechanical and elevator machine rooms on latch side of door.

3.6 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 specified or indicated, verify before proceeding with installation.

.3 Install electrical equipment at following heights unless indicated otherwise.

.1 Local switches: 1,400 mm.

.2 Wall receptacles:

.1 General: 450 mm.

.2 Above top of counters or counter splash backs: 175 mm.

.3 In mechanical rooms: 1,400 mm.

3.7 CO-ORDINATION OF PROTECTIVE DEVICES

.1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

3.8 FIELD QUALITY CONTROL

.1 Load Balance:

.1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.

.2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

.3 Provide upon completion of work, load balance report as directed in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS, phase and neutral currents on panelboards, dry-core transformers, and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.

.2 Provide instruments, meters, equipment, and personnel required to conduct tests during and at conclusion of project.

.3 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting, and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.9 SYSTEM STARTUP

.1 Instruct HRCE Representative in operation, care and maintenance of systems, system equipment, and components.

.2 Arrange and pay for services of manufacturer's factory service representative to supervise start-up of installation, check, adjust, balance, calibrate components, and instruct operating personnel.

.3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

3.10 COMMISSIONING

.1 Participate in commissioning in accordance with Section 01 91 13 - General Commissioning Requirements.

3.11 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

END OF SECTION

Part 1 General

1.1 DEFINITIONS

.1 Demolish: Detach items from existing construction and legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.

.2 Remove: Planned deconstruction and disassembly of electrical items from existing construction including removal of conduit, junction boxes, cabling, and wiring from electrical component to panel taking care not to damage adjacent assemblies designated to remain; legally dispose of items off-site, unless indicated as removed and salvaged, or removed and reinstalled.

.3 Remove and Salvage: Detach items from existing construction and deliver them to HRCE Representative ready for reuse.

.4 Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.

.5 Existing to Remain: Existing items of construction that are not removed and that are not otherwise indicated as being removed and salvaged, or removed and reinstalled.

.6 Hazardous Substances: Dangerous substances, dangerous goods, hazardous commodities and hazardous products may include asbestos, mercury and lead, PCB's, poisons, corrosive agents, flammable substances, radioactive substances, or other material that can endanger human health or wellbeing or environment if handled improperly as defined by Federal Hazardous Products Act (RSC 1985) including latest amendments.

1.2 REFERENCE STANDARDS

.1 CSA Group (CSA):

.1 CSA S350 M1980 (R2003), Code of Practice for Safety in Demolition of Structures.

1.3 ADMINISTRATIVE REQUIREMENTS

.1 Coordination: Coordinate work of this Section to avoid interference with work by other Sections.

1.4 SITE CONDITIONS

.1 Discovery of Hazardous Substances: It is not expected that Hazardous Substances will be encountered in Work; immediately notify HRCE Representative if materials suspected of containing hazardous substances are encountered and perform following activities:

.1 Hazardous substances will be as defined in Hazardous Products Act.

.2 Stop work in area of suspected hazardous substances.

.3 Take preventative measures to limit users' and workers' exposure, provide barriers and other safety devices and do not disturb.

.4 Proceed only after written instructions have been received from HRCE Representative.

1.5 SALVAGE AND DEBRIS MATERIALS

.1 Demolished items become Contractor's property and will be removed from Project site; except for items indicated as being reused, salvaged, or otherwise indicated to remain HRCE's property.

.2 Carefully remove materials and items designated for salvage and store in a manner to prevent damage or devaluation of materials.

Part 2 Products

2.1 MATERIALS

.1 Electrical Repair Materials: Use only new materials, CSA or ULC labelled as appropriate and matching components remaining after work associated with components identified for removal or demolition are completed

.2 Fire stopping Repair Materials: Use fire stopping materials compatible with existing fire stopping systems where removal or demolition work affects rated assemblies, restore to match existing fire rated performance.

Part 3 Execution

3.1 EXAMINATION

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

3.2 PREPARATION

.1 Protection of Existing Systems to Remain: Protect systems and components indicated to remain in place during selective demolition operations and as follows:

.1 Prevent movement and install bracing to prevent settlement or damage of adjacent services and parts of existing buildings scheduled to remain.

.2 Notify HRCE Representative and cease operations where safety of buildings being demolished, adjacent structures or services appears to be endangered and await additional instructions before resuming demolition work specified in this Section.

.3 Prevent debris from blocking drainage inlets.

.4 Protect mechanical systems that will remain in operation.

.2 Protection of Building Occupants: Sequence demolition work so that interference with the use of the building by the HRCE Representative and users is minimized and as follows:

.1 Prevent debris from endangering safe access to and egress from occupied buildings.

.2 Notify HRCE Representative and cease operations where safety of occupants appears to be endangered and await additional instructions before resuming demolition work specified in this Section.

3.3 EXECUTION

.1 Demolish and Remove materials as indicated on drawings. Coordinate demolition activities and sequence with other trades. Where indicated:

- .1 Disconnect electrical circuits and panel feeders; maintain electrical service and main distribution panel as is, ready for subsequent Work.
- .2 Remove existing luminaires, electrical devices and equipment including associated conduits, boxes, wiring, and similar items unless specifically noted otherwise.
- .3 Disconnect and remove existing fire alarm system including associated conduits, boxes, wiring, and similar items unless specifically noted otherwise.
- .4 Disconnect and remove communication systems including associated conduits, boxes, cabling, and similar items unless specifically noted otherwise.
- .5 Disconnect and remove telephone outlets, associated conduit, cabling, and sub terminal backboards and related accessories; maintain telephone service and main terminal backboard as is.
- .6 Perform demolition work in a neat and workmanlike manner:
  - .1 Remove tools or equipment after completion of work, and leave site clean and ready for subsequent renovation work.
  - .2 Repair and restore damages caused as a result of work of this Section to match existing materials and finishes.
- .7 Disconnect panel feeders back to main distribution panel and re label respective circuit breaker as "SPARE".
- .8 Place weatherproof blank cover plates on exterior outlet boxes remaining after demolition and removal activities.
- .9 Remove existing conduits, boxes, cabling, and wiring associated with removed luminaires, electrical devices, and equipment.
- .10 Grind off conduits and make flush with surface of concrete where conduits are cast into concrete; seal open ends of conduit with silicone sealant and leave in place.
- .11 Seal open ends of conduit with silicone sealant and leave in place where they are inaccessible or cannot be removed without damaging adjacent construction.

3.4 CLOSEOUT ACTIVITIES

.1 Demolition Waste Disposal: Arrange for legal disposal and remove demolished materials to accredited Provincial landfill site or alternative disposal site (recycle centre) except where explicitly noted otherwise for materials being salvaged for re-use in new construction.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 CSA Group (CSA):

.1 C22.2 No. 18.1-13 (R2022), Metallic Outlet Boxes.

.2 C22.2 No. 18.2:06 (R2021), Nonmetallic Outlet Boxes.

.3 C22.2 No. 18.3:12 (R2022), Conduit, Tubing, And Cable Fittings.

.4 C22.2 No. 18.4:15 (R2019), Hardware For The Support Of Conduit, Tubing, And Cable.

.5 CAN/CSA-C22.2 No. 65-18 (R2022) Wire Connectors (Tri-National Standard with NMX-J-543-ANCE and UL 486A-486B).

.2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC):

.1 EEMAC 1Y-2-1961, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature, and data sheets for wire, and box connectors and include product characteristics, performance criteria, physical size, finish, and limitations.

1.3 CLOSEOUT SUBMITTALS

.1 Operation and Maintenance Data: submit operation and maintenance data for wire and box connectors for incorporation into manual.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

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 copper 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.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for wire and box connectors installation in accordance with manufacturer's written instructions:

.1 Visually inspect substrate in presence of HRCE Representative.

.2 Inform HRCE Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from HRCE Representative.

3.2 INSTALLATION

.1 Remove insulation carefully from ends of conductors and cables and:

.1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.

.2 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CAN/CSA-C22.2 No. 65.

.3 Install fixture type connectors and tighten to CAN/CSA-C22.2 No. 65. Replace insulating cap.

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

3.3 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment in accordance with Section 01 74 00 - Cleaning.

END OF SECTION

Part 1 General

1.1 DELIVERY, STORAGE, AND HANDLING

.1 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 BUILDING WIRES

.1 Conductors: stranded for 10 AWG and larger. Solid for 12 AWG and smaller. Minimum size: 12 AWG.

.2 Copper conductors: size as indicated, with 600 V insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE, Non-Jacketed.

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 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.

.6 Branch circuit wiring for surge suppression receptacles and permanently wired computer and electronic equipment to be 2-wire circuits only, i.e. common neutrals not permitted.

.7 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.

3.3 INSTALLATION OF BUILDING WIRES

.1 Install wiring as follows:

.1 In conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 CSA Group (CSA)

.1 CSA C22.1-24, Canadian Electrical Code, Part 1, 26th Edition.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Provide manufacturer's printed product literature, specifications, and datasheet and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Provide shop drawings: in accordance with Section 01 33 00 - Submittal Procedures.

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Nova Scotia, Canada.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

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 flat covers.

Part 3 Execution

3.1 JUNCTION, PULL BOXES, AND CABINETS INSTALLATION

.1 Install pull boxes in inconspicuous but accessible locations.

.2 Mount cabinets with top not higher than 2 m above finished floor except where indicated otherwise.

.3 Install terminal block as indicated in Type T cabinets.

.4 Only main junction and pull boxes are indicated. Install additional pull boxes as required by CSA C22.1

3.2 IDENTIFICATION

.1 Equipment Identification: to Section 26 05 00 - Common Work Results for Electrical.

.2 Identification Labels: size 2 indicating system name and voltage/phase or as indicated.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 CSA Group (CSA)

.1 CAN/CSA C22.2 No. 18-98 (R2003), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.

.2 CSA C22.2 No. 45-M1981 (R2003), Rigid Metal Conduit.

.3 CSA C22.2 No. 56-04, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.

.4 CSA C22.2 No. 83-M1985 (R2003), Electrical Metallic Tubing.

.5 CSA C22.2 No. 211.1-06 (R2021), Rigid types EB1 and DB2/ES2 PVC Conduit.

.6 CSA C22.2 No. 211.2-06 (R2021), Rigid PVC (Unplasticized) Conduit.

.7 CAN/CSA C22.2 No. 227.3-05, Nonmetallic Mechanical Protection Tubing (NMPT), A National Standard of Canada (February 2006).

.8 CSA C22.2 No. 327-18 (R2023), HDPE Conduit, Conductors-in-Conduit, and Fittings.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product data: submit manufacturer's printed product literature, specifications, and datasheets:

.1 Submit cable manufacturing data.

.2 Quality assurance submittals:

.1 Test reports: submit certified test reports.

.2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.3 Instructions: submit manufacturer's installation instructions.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 CONDUITS

.1 Electrical Metallic Tubing (EMT): to CSA C22.2 No. 83, with couplings or with expanded ends.

.2 Rigid PVC conduit: to CSA C22.2 No. 211.2.

.3 Flexible metal conduit: to CSA C22.2 No. 56, steel or aluminum.

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 Threaded rods, 6 mm diameter, to support suspended channels.

2.3 CONDUIT FITTINGS

.1 Fittings: Manufactured for use with conduit specified. Coating: same as conduit.

.2 Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.

2.4 EXPANSION FITTINGS FOR RIGID CONDUIT

.1 Weatherproof expansion fittings with internal bonding assembly suitable for 200 mm linear expansion.

.2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.

.3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.5 FISH CORD

.1 Polypropylene.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

.2 Conceal conduits except in mechanical and electrical service rooms.

.3 Surface mount conduits except where otherwise shown.

.4 Use Electrical Metallic Tubing (EMT) for interior work.

.5 Use rigid PVC conduit for exterior work.

.6 Use flexible metal conduit for connection to motors in dry areas.

.7 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.

.8 Install conduit sealing fittings in hazardous areas:

.1 Fill with compound.

.9 Minimum conduit size for lighting and power circuits: 21 mm.

.10 Bend conduit cold:

.1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.

.11 Mechanically bend steel conduit over 19 mm diameter.

.12 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

.13 Install fish cord in empty conduits.

.14 Remove and replace blocked conduit sections:

.1 Do not use liquids to clean out conduits.

.15 Dry conduits out before installing wire.

3.3 SURFACE CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.

.3 Run conduits in flanged portion of structural steel.

.4 Group conduits wherever possible on surface channels.

.5 Do not pass conduits through structural members except as indicated.

.6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

3.4 CONCEALED CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Do not install horizontal runs in masonry walls.

.3 Do not install conduits in terrazzo or concrete toppings.

3.5 CONDUITS UNDERGROUND

.1 Slope conduits to provide drainage.

.2 Waterproof joints (PVC excepted) with heavy coat of bituminous paint.

3.6 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 CSA Group (CSA):

.1 CSA C22.2 No. 42-10, General Use Receptacles, Attachment Plugs and Similar Devices.

.2 CAN/CSA C22.2 No. 42.1-00 (R2009), Cover Plates for Flush-Mounted Wiring Devices (Bi-National Standard, with UL 514D).

.3 CSA C22.2 No. 55-M1986 (R2008), Special Use Switches.

.4 CSA C22.2 No. 111-10, General-Use Snap Switches (Bi-National Standard, with UL 20).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature, and data sheets for wiring devices and include product characteristics, performance criteria, physical size, finish, and limitations.

1.3 CLOSEOUT SUBMITTALS

.1 Operation and Maintenance Data: submit operation and maintenance data for wiring devices for incorporation into manual.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, and/or packaging materials.

Part 2 Products

2.1 RECEPTACLES

.1 Duplex receptacles, CSA type 5-20 R, 125 V, 20 A, U ground, to: CSA C22.2 No. 42 with following features:

.1 Complete with integral ground fault circuit interrupter and weatherproof enclosure where indicated.

.2 Suitable for No. 10 AWG for back and side wiring.

.3 Break-off links for use as split receptacles.

.4 Eight back wired entrances, four side wiring screws.

.5 Triple wipe contacts and rivetted grounding contacts.

.2 Receptacles of one manufacturer throughout project.

2.2 COVER PLATES

.1 Cover plates for wiring devices to: CSA C22.2 No. 42.

.2 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.

.3 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.

.4 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.

2.3 SOURCE QUALITY CONTROL

.1 Cover plates from one manufacturer throughout project.

Part 3 Execution

3.1 INSTALLATION

.1 Receptacles:

.1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.

.2 Mount receptacles at height as indicated.

.3 Where split receptacle has one portion switched, mount vertically and switch upper portion.

.4 Install GFCI type receptacles as indicated.

.2 Cover plates:

.1 Install suitable common cover plates where wiring devices are grouped.

.2 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

3.2 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

3.3 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.

.3 Repair damage to adjacent materials caused by wiring device installation.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 CSA Group (CSA):

.1 CSA C22.2 No. 5-16 (R2021), Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-National Standard with UL 489 and NMX-J-266-ANCE-2016).

.2 CAN/CSA-C22.2 No. 144-M91 (R2020), Ground Fault Circuit Interrupters.

.3 CSA C22.2 No.144.1-16 (R2020), Ground-Fault Circuit-Interrupters (Tri-National Standard with UL 943 and NMX-J-520-ANCE).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's instructions, product literature, and data sheets for circuit breakers. Include product characteristics, performance criteria, physical sizes, finishes, and limitations.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 BREAKERS - GENERAL

.1 All circuit breakers: To CSA C22.2 No. 5.

.2 Bolt-on Moulded Case Circuit Breakers: Over-centre, trip-free toggle-operating mechanism to provide quick-make, quick-break contact action, for manual and automatic operation with temperature compensation for 40 °C ambient.

.3 Common-Trip Breakers: With single handle for multi-pole applications.

.4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.

.5 Symmetrical rms interrupting capacity to match panelboard rating.

2.2 THERMAL MAGNETIC BREAKERS

.1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short-circuit protection.

2.3 GROUND FAULT CIRCUIT INTERRUPTER BREAKERS

.1 Ground fault circuit interrupter (GFCI) breakers: To CAN/CSA-C22.2 No. 144 and 144.1, Class A Type, single-pole GFCI breakers, rating as scheduled, complete with test and reset facilities.

Part 3 Execution

3.1 INSTALLATION

.1 Install circuit breakers as indicated.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 CSA Group:

.1 CAN/CSA-C22.2 No. 4-04 (R2009), Enclosed and Dead-Front Switches (Tri-National Standard, with ANCE NMX-J-162-2004 and UL 98).

.2 CSA C22.2 No. 39-13, Fuseholder Assemblies.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature, and data sheets for disconnect switches - fused and non-fused and include product characteristics, performance criteria, physical size, finish, and limitations.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 DISCONNECT SWITCHES

.1 Non-fusible, disconnect switch in CSA enclosure as per drawings, size as indicated.

.2 Provision for padlocking in on and off switch position by 2 locks.

.3 Mechanically interlocked door to prevent opening when handle in ON position.

.4 Quick-make and quick-break action.

.5 ON-OFF switch position indication on switch enclosure cover.

2.2 EQUIPMENT IDENTIFICATION

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

.2 Indicate name of load controlled on size 4 nameplate.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for disconnect switches - fused and non-fused installation in accordance with manufacturer's written instructions:

.1 Visually inspect substrate in presence of HRCE Representative.

.2 Inform HRCE Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from HRCE Representative.

3.2 INSTALLATION

.1 Install disconnect switches complete with fuses if applicable.

3.3 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 03 30 00 - Cast-in-Place Concrete.

1.2 REFERENCE STANDARDS

.1 ASTM International (ASTM):

.1 ASTM A53/A53M-22, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

.2 ASTM A90/A90M-21, Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.

.3 ASTM A123/A123M-17, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

.4 ASTM A653/A653M-22, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.2 Canadian General Standards Board (CGSB):

.1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.

.2 CAN/CGSB-138.1-19, Fabric for Chain Link Fence.

.3 CAN/CGSB-138.2-19, Steel Framework for Chain Link Fence.

.4 CAN/CGSB-138.3-19, Installation of Chain Link Fence.

.5 CAN/CGSB-138.4-19, Gates for Chain Link Fence.

.3 CSA Group (CSA):

.1 CSA A23.1:19/CSA A23.2:19, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

.2 CSA A3000-18, Cementitious Materials Compendium.

.4 The Master Painters Institute (MPI):

.1 Architectural Painting Specification Manual, Current Edition.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's instructions, product literature, and data sheets for concrete mixes, fence fabric, posts, and gates. Include product characteristics, performance criteria, metal thickness, finishes, and limitations.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Delivery and Acceptance Requirements: Deliver materials to site in original factory packaging labelled with manufacturer's name and address.

.2 Packaging Waste Management: Remove packaging materials for reuse by manufacturer as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

.1 Concrete Materials: In accordance with Section 03 30 00 - Cast-in-Place Concrete:

- .1 Compressive strength: Minimum 20 MPa at 28 days.
- .2 Additives: Fly ash to CSA A3000.

.2 Chain-Link Fence Fabric: To CAN/CGSB-138.1:

- .1 Type 1, Class B, heavy gauge, Grade 1 or 2.
- .2 Mesh diamond size: 50 mm.
- .3 Height of fabric: As indicated on Drawings.

.3 Posts, Braces, and Rails: To CAN/CGSB-138.2, galvanized steel pipe. Dimensions as indicated on Drawings.

.4 Top and Bottom Tension Wire: To CAN/CGSB-138.2, single strand, galvanized steel wire.

.5 Tie Wire Fasteners: Aluminum wire.

.6 Tension Bar: To ASTM A653/A653M, minimum 5 mm x 20 mm galvanized steel.

.7 Gates: To CAN/CGSB-138.4.

.8 Gate Frames: To ASTM A53/A53M, galvanized steel pipe, standard weight:

- .1 Outside frame pipe: 45 mm outside diameter pipe.
- .2 Interior bracing pipe: 35 mm outside diameter pipe.
- .3 Fabricate gates as indicated on Drawings with electrically welded joints, and hot-dip galvanized. After welding touch-up welded areas with inorganic zinc rich paint.
- .4 Fasten fence fabric to gate with twisted selvage at top.
- .5 Provide gates with the following gate hardware:
  - .1 Galvanized malleable iron hinges.
  - .2 Latch.
  - .3 Latch catch designed for padlock which can be attached and operated from both sides of gate.

.9 Fittings and Hardware: To CAN/CGSB-138.2, galvanized steel:

- .1 Tension bar bands: Minimum 3-mm x 20-mm galvanized steel or minimum 5-mm x 20-mm aluminum.
- .2 Post caps to:
  - .1 Provide waterproof fit,
  - .2 Fasten securely over posts, and
  - .3 Carry top rail.

.10 Organic Zinc-Rich Coating: To CAN/CGSB-1.181.

2.2 FINISHES

.1 Galvanizing:

.1 For chain-link fabric: To CAN/CGSB-138.1 Grade 2.

.2 For pipe: Minimum 550 g/m^2 to ASTM A90.

.3 For other fittings: To ASTM A123/A123M.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: Verify all dimensions, elevations, and alignment of new and existing work prior to fabrication:

.1 Inform HRCE Representative of unacceptable conditions immediately upon discovery.

3.2 PREPARATION

.1 Grading: Remove debris and correct ground undulations along fenceline to obtain smooth uniform gradient between posts:

.1 Provide clearance between bottom of fence and ground surface of 30 mm to 50 mm.

3.3 INSTALLATION FENCE

.1 Install fence to CAN/CGSB-138.3, along fencelines indicated on Drawings.

.2 Excavate post holes to dimensions indicated on Drawings.

.3 Install end posts at end of fence and at buildings:

.1 Install gate posts on both sides of gate openings.

.4 Place concrete in post holes then embed posts into concrete to depths indicated on Drawings:

.1 Extend concrete 50 mm above ground level. Slope upper concrete surface to drain water away from posts.

.2 Temporarily brace posts in plumb position and true to alignment and elevation until concrete has set.

.5 Allow concrete to cure a minimum of 7 days before beginning installation of fence fabric.

.6 Install brace between end and gate posts and nearest line post, placed in centre of panel and parallel to ground surface:

.1 Install braces on both sides of corner and straining posts in similar manner.

.7 Install overhang tops and caps.

.8 Install top rail between posts and fasten securely to posts and secure waterproof caps and overhang tops.

.9 Install bottom tension wire, stretch tightly and fasten securely to end, corner, gate, and straining posts with turnbuckles and tension bar bands.

.10 Lay out fence fabric. Stretch tightly to tension recommended by manufacturer and fasten to end, corner, gate and straining posts with tension bar secured to post with tension bar bands spaced at 300 mm intervals:

.1 Knuckled selvedge at bottom.

.2 Twisted selvedge at top.

.11 Secure fabric to top rails, line posts and bottom tension wire with tie wires at 450-mm intervals:

.1 Give tie wires a minimum of two twists.

3.4 INSTALLATION OF SWING GATES

.1 Install gates in locations as indicated on Drawings. Before fence fabric is installed, HRCE Representative may make minor adjustments to exact gate locations that do not alter the quantity of materials.

.2 Level ground between gate posts and set gate bottom approximately 40 mm above ground surface.

.3 Determine position of centre gate rest for double gate:

.1 Cast gate rest into concrete.

.2 Slope upper concrete surface to drain water away from gate rest.

.4 Install gate stops where indicated on Drawings.

3.5 ADJUSTING

.1 Clean and prepare damaged surfaces with wire brush removing loose and cracked coatings, rust, and foreign materials. Prepare damaged surfaces according to paint manufacturer’s instructions. Apply two coats of organic zinc-rich paint to damaged areas.

3.6 CLEANING

.1 Cleaning: Perform in accordance with Section 01 74 00 - Cleaning.

.2 Waste Management: Perform in accordance with Section 01 74 19 - Waste Management and Disposal.

END OF SECTION