High Park Visitor and Nature Centre
Parks, Forestry & Recreation
City of Toronto
Toronto, Ontario

23 Morrow Avenue
Toronto, Canada
M6R 2H9
Tel 416 504 8998
Fax 416 504 6556
Email office@kongatsarchitects.com

KONGATS ARCHITECTS

Project No: 2205
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SPECIFICATIONS
Volume 2

Mechanical and Electrical

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Read and conform to:

.1 The Contract CCDC 2-2008, Stipulated Price Contract as amended,

.2 Division 01 requirements and documents referred to therein.

.2 This Section applies to and governs the work of Division 21.

.3 The technical Sections of this Division are generally divided into units of work for the purpose of ready reference. The division of the work among subcontractors is not the Consultant's responsibility and the Consultant assumes no responsibility to act as an arbiter and/or to establish subcontract limits between any Sections of the work.

.4 The specifications are integral with the drawings which accompany them. Neither is to be used alone. Any item or subject omitted from one but implied in the other is fully and properly required.

.5 Wherever differences occur in the tender documents, the most onerous condition governs. Base the bid on the costliest arrangement.

1.2 DEFINITIONS

.1 The following are definitions of words found in this specification and on associated drawings under this Division:

.1	"Concealed"	locations hidden from normal sight in furred spaces, shafts, ceiling spaces, walls, and partitions.
.2	"Exposed"	mechanical work normally visible to building occupants.
.3	"Furnish"	(and its derivatives) has the same meaning as the term "Supply".
.4	"Install"	(and its derivatives) - receive, store and handle at the site, mount and support and connect all required services. Includes adjustment and calibration, testing, commissioning, inspection by authorities having jurisdiction and documentation.
.5	"Provide"	(and its derivatives) - supply, install in place, connect the associated required services ready for operation, adjust and calibrate, test, commission, warrant, and document. Includes inspection by authorities having jurisdiction.
.6	"Supply"	(and its derivatives) purchase and deliver to the site for installation. Includes submittals, manufacturer's field inspection and warranty.

.7 "Wet" locations exposed to moisture, requiring special materials and arrangement.

1.3 WORK INCLUDED

.1 Products and methods mentioned or shown in the Contract Documents complete with incidentals necessary for a complete operating installation. Provide tools, equipment and services required to do the work.

.2 Cutting and patching of new or existing work

.3 Identification of piping and valves

.4 Take such measures and include in Bid Price for the proper protection of the existing building and its finishes during alterations and construction. Coordinate this protective work with other trades.

.5 Take measures to prepare and execute a fire watch plan during construction period when the fire protection systems are not operational.

.6 Verify the correct operation of each sprinkler zone provided and/or altered and obtain the Owner's approval prior to starting and/or returning to operation.

1.4 SUBMITTALS

.1 Approval Drawings: Prepare and submit stamped Fire Protection drawings necessary for approval to authority having jurisdiction and obtain two (2) copies of approved drawings for retention by Consultant prior to commencement of work under this Division.

.2 Shop Drawings: Prepare and submit two (2) copies of stamped shop drawings indicating the relocation/alteration and addition of sprinkler heads for each individual zone to the Consultant for review. The Consultant will return one copy, marked with comments and his review stamp as he deems appropriate. Prepare the necessary number of copies of the returned set and distribute to the Owner, the Prime Consultant, the General Contractor, the site, and to subcontractors and suppliers.

.1 Clearly indicate manufacturer's and supplier's names, catalogue model numbers, details of construction, accurate dimensions, capacities, and performance. Prior to submission check and certify as correct, shop drawings and data sheets. Do not order equipment until a copy of the shop drawings, reviewed by Consultant, has been returned to Contractor.

.2 Clearly indicate the sprinkler zone, hazard type, pipe routing, location of sprinkler heads, type of sprinkler heads, method of support and anchor point forces and locations for each piece on shop drawings.

.3 The Consultant will not review shop drawings that fail to bear the Contractor's stamp of approval or certification.

.4 Read the following in conjunction with the wording on the shop drawing review stamp applied to each drawing submitted:

.1 "This review by the Consultant is for the sole purpose of ascertaining conformance with general design concept. This review shall not mean that the Consultant approves the detailed design inherent in the shop drawings, responsibility for which shall remain with the Contractor submitting same, and such review shall not relieve the Contractor of his responsibility for errors or omissions in the shop drawings or of his responsibility for meeting all requirements of the Contract Documents. The Contractor is responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for coordination of the work of all sub trades."

.3 As-Built Records: Prepare and submit complete as-built records prior to Substantial Performance of the Contract. Refer to paragraph 3.3 and to Division 1 for requirements. Submit two sets of as-builts drawings in AutoCAD format showing changes & concealed services dimensioned. AutoCAD files can be provided to the contractor by the Consultant at a fee of $300.00 plus $25.00 per sheet upon request.

.4 Requests for Shut-Down: Obtain permission for systems shut-down and/or service interruption from the Owner prior to disruption of any system or service in use by the Owner. Employ the Owner's standard form of request where available. Refer to Division 1 for additional requirements.

.5 Requests for Start-up: Obtain permission from the Owner to start-up or to return to service any item of equipment, system or service installed new or previously shutdown. Refer to Division 1 for additional requirements.

.6 Contractor's Material and Test Certificates: Prepare and submit certificates for each system installed. Where certificates are prescribed by regulations, codes or standards ensure they conform to the requirements of those documents (e.g. NFPA-standards). Include a copy of each certificate in the Operation and Maintenance manual. Include the following:

.1 description of the system (description and type),

.2 description of the tests conducted, and results observed, including re-testing, where necessary,

.3 description of corrective measures undertaken,

.4 description of materials used (pipe and fittings),

.5 list of witnesses for each test conducted,

.6 date system left ready for service,

.7 signature of installing Contractor.

.7 Maintenance Data and Operating Instructions

.1 Submit three (3) copies of Operation and Maintenance Manual individually bound in hard backed three-ring binders.

.2 Ensure the binder spines have typewritten lettering as follows:

OPERATION & MAINTENANCE MANUAL

for

"Insert project name"

"Insert date of submission"

Division 21 00 00

.3 Provide a list of names, addresses and telephone numbers of equipment suppliers, installing contractors, general contractors, architect and Consultant. Include special telephone numbers for service departments on normal and emergency call basis.

.4 Provide descriptive literature (shop drawings) of each manufactured item. Include a bill of material with purchase order numbers and vendor's identification of equipment orders for each item.

.5 Include copies of start-up reports and checklists and all certificates issued with respect to this contract.

.6 Ensure operating instructions include the following:

.1 General description of each fire suppression system altered as part of this project.

.2 Step by step procedure to follow in putting each piece of equipment into service.

.7 Ensure maintenance instructions include the following:

.1 Manufacturer's maintenance instructions for each item of mechanical equipment installed under this Division. Instructions shall include installation instructions, parts numbers and lists, name of supplier and maintenance instructions.

.2 Summary list of each item of mechanical equipment.

.3 Equipment directory indicating name, model, serial number and nameplate data of each item of equipment supplied, and system with which it is associated.

.4 Copy of valve directory.

.8 As-Built Records: Prepare and submit complete as-built records prior to Substantial Performance of the Contract. Refer to Division 01 for requirements.

1.5 QUALITY ASSURANCE

.1 Conform to minimum requirements or better of provincial and local codes, where existing, and to requirements of local inspection authorities for execution of work under this Division.

.2 Ensure materials supplied under this Division conform to minimum requirements

and recommendations or better of applicable standards of the following:

.1 NFPA National Fire Protection Association

.2 OBC Ontario Building Code

.3 OFC Ontario Fire Code

.4 OFM Ontario Fire Marshall

.3 Use latest editions and amendments in effect on date of bid call subject to requirements of OBC.

.4 Arrange and pay for permits and inspections by authorities having jurisdiction, required in the undertaking of this Division. Make modifications required by authorities.

.5 All tradesmen employed on the project shall hold valid trade certificates/licenses and shall make a copy available for review by the Consultant and/or Owner when requested.

1.6 JOB CONDITIONS

.1 Visit site and examine existing conditions which may affect work of this Division.

.2 Examine Contract Documents to ensure that work of this Division may be satisfactorily completed.

.3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.

.4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without qualifications unless exceptions are specifically noted in the Bid.

1.7 WARRANTY

.1 Refer to General Conditions.

.2 Arrange with each manufacturer/supplier to extend warranties as necessary to coincide with warranty period or those periods specified.

1.8 EXTRAS AND CREDITS

.1 Accompany price submissions requested by Consultant for extra work, or work to be deleted, with a complete cost breakdown as follows:

.1 Materials, quantities, and unit costs including any applicable contractors trade discount clearly identified. Provide supplier quotations.

.2 Labour hours and unit costs.

.3 Total materials and labour costs.

.4 Overhead and profit mark-ups in accordance with the General Conditions of the Contract.

.2 Quotations from software such as Allpriser will not be accepted. Provide actual material costs.

2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

.1 Ensure materials and equipment provided under this Division are new and free from defects and bear labels of approval as required by codes referred to in this Division and/or by inspection authorities.

.2 Ensure manufacturers and suppliers of equipment or materials under this Division determine if their products are composed of any hazardous materials. If they are, the products are suitably labeled and supplied with Material Safety Data sheets. Obtain the Owner's approval in writing to bring hazardous materials onto the site prior to doing so.

.3 When utilizing any products that are hazardous, keep Material Safety Data sheets on file at the job site and present them to anyone requesting this information. When transferring hazardous materials from original container into other containers, provide Workplace Labels on such containers.

2.2 ACCEPTABLE PRODUCTS

.1 First item named or specified by catalogue number meets specifications regarding performance, quality of material and workmanship, and is acceptable to the Consultant.

.2 Items, other than first named, meeting specifications regarding quality of materials and workmanship are acceptable to the Consultant, only if they also meet performance and/or capacities specified and can be accommodated within the space allotted.

.3 General approval indicated by inclusion of other manufacturers named is subject to final review of shop drawings, performance data and test reports.

2.3 EQUIVALENTS AND ALTERNATIVES

.1 Suppliers wishing approval for additional equipment items or alternatives as equivalent to those specified **must submit complete description, technical and performance data to the Consultant at least twelve (12) working days prior to Bid closing date.** Such equivalent equipment, if accepted, must conform to specifications regarding details, accessories, modifications, features and performance. Deviations from specifications must be stated in writing at time of submission for approval.

.2 Only include products specified or approved equivalents.

2.4 SUBSTITUTIONS DURING PROGRESS OF WORK

.1 Refer to Division 01.

2.5 CONSULTANT'S REVIEW

.1 The consultants will review and evaluate unsolicited alternatives and substitutions proposed by the Contractor. Such review and evaluation work will be undertaken by the Consultant on an additional fee basis. Reimburse the Owner for costs associated with such reviews and evaluations.

.2 Reimburse the Owner for costs incurred in updating Contract Documents to reflect such changes.

3 EXECUTION

3.1 RELATIONSHIP WITH OTHER TRADES

.1 Cooperate with other trades whose work affects or is affected by work of this Division to ensure satisfactory installation and to avoid delays.

3.2 INSTALLATION REQUIREMENTS

.1 The Consultant's drawings and instructions govern the location of all items. Prepare fully coordinated installation drawings prior to installation.

.2 Install equipment neatly to the satisfaction of the Consultant. Unless noted, install products and services to follow building planes. Ensure installation permits free use of space and maximum headroom.

.3 Do not use powder activated tools except as permitted by the Prime Consultant and the Owner's workplace health and safety policies.

3.3 CONTRACT DRAWINGS

.1 The drawings of this Division are performance drawings and indicate general arrangement of the work. They are diagrammatic except where specific details are given.

.2 Obtain accurate dimensions from the architectural and structural drawings, or by measurement. Location and elevation of services are approximate. Verify them before construction is undertaken.

.3 Make changes where required to accommodate structural conditions (beams, columns, etc.). Obtain Consultant's approval before proceeding.

.4 Adjust the location of materials and/or equipment as directed without adjustment to contract price, provided that the changes are requested before installation and do not affect material quantity. **Note that Products may be relocated up to 10 feet (3 m) in any direction without a change to the contract price**.

.5 Note that the layout and orientation of the ceiling outlets on the architectural reflected ceiling drawings may differ from that shown on the mechanical drawings. Make the installation in accordance with the latest architectural ceiling drawings. Provide the equipment as specified and/or shown on the documents of this Division.

.6 The drawings of this Division are intended for tender pricing. The quantities and quality to be included in the bid price shall be based on the layout and specifications as shown on the mechanical documents. If there is a difference in quantity between the architectural and drawings of this Division, base the contract price on the greater quantity.

.7 Prepare installation (construction) drawing to reflect the latest architectural ceiling layout.

3.4 INSTRUCTION

.1 Instruct and familiarize Owner's operating personnel with the various mechanical systems. Arrange instructions for each system separately.

.2 Provide instruction for each system on two separate occasions, coordinated with the Owner's staff operating schedule, in order that interested personnel may arrange to attend.

.3 Ensure each instruction period includes, but is not limited to the following:

.1 a classroom seminar with operating manuals, product and system drawings and such other audio/visual aids as may be appropriate,

.2 instruction during the classroom seminar by the manufacturer's representative regarding the proper operating and maintenance procedures for each item of equipment,

.3 demonstration of the proper operating procedures for each item of equipment,

.4 explanation of the purpose and function of all safety devices provided,

.5 demonstration of all measures required for safe and proper access for operation and maintenance.

.4 Provide a period of follow-up instruction (on two occasions) approximately one month after completing Owner's instruction to clarify and reinforce earlier instructions.

.5 Submit a letter from the Owner's management staff indicating the instruction has been given satisfactorily to the Consultant prior to substantial completion of the project.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Division 01.

1.2 SECTION INCLUDES

.1 Identification of existing services.

.2 Installation, protection and maintenance of temporary services as required to support continuing operation of the facility.

.3 Disconnection and making safe of sprinkler and fire suppression systems and equipment in areas to be demolished and/or renovated.

.4 Disposal of waste materials in accordance with waste management requirements.

1.3 REGULATORY REQUIREMENTS

.1 Notify authorities of intent to demolish and schedule for the work. Obtain required permits from authorities.

.2 Conform to codes for demolition work, dust control, products requiring disconnection and re-connection.

.3 Do not close or obstruct egress width to any building or site exit.

.4 Do not disable or disrupt building fire or life safety systems without 3 days prior written notice to Owner.

.5 Conform to procedures applicable when hazardous or contaminated materials are discovered.

.6 Arrange for re-certification and inspection of changes made to any equipment, machine or apparatus by authorities having jurisdiction. This includes requirements for marking equipment under rules 2-100 and 2-102 of the Ontario Electrical Safety Code.

1.4 JOB CONDITIONS

.1 Visit site and examine existing conditions which may affect work of this Division.

.2 Examine Contract Documents to ensure that work of this Division may be satisfactorily completed.

.3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.

.4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without qualifications, unless exceptions are specifically noted in the Bid.

1.5 INTERRUPTIONS

.1 Arrange execution of work to maintain present building operations, and to minimize the effect of work under this Division on existing operations.

.2 Prior to interrupting any existing service notify the Owner and Consultant, in writing, at least Seven (7) days in advance, and obtain written authorization. Do not interrupt existing service without Consultant's specific authorization. Refer to Division 01 for requirements.

.3 Include in Bid Price for overtime or premium time hours necessary to minimize duration of service interruption.

.4 Test and verify the proper operation of existing equipment and systems that are shut down due to work of this project, prior to returning to service.

.5 Assume responsibility for consequential costs on failure to obtain permission to shut down and/or start-up any item of equipment, system or service.

1.6 PHASING AND SCHEDULING

.1 Refer to Division 01 phasing and scheduling of the work.

.2 Coordinate with the work of all Sections of Division 21, 23, 25 and with other trades and assist in the development of the Phasing Strategy.

1.7 FIRE WATCH

.1 Prior to commencing work, prepare a fire watch plan and submit to the owner, and prime consultant for approval.

.2 Do not commence Work without written approval by Owner and prime consultant of the fire watch plan.

.3 Execute the fire watch plan during the shutdown period of the sprinkler system.

.4 Keep a copy of the fire watch plan at the project site.

2 PRODUCTS

2.1 PRODUCTS

.1 (N/A)

3 EXCECUTION

3.1 PREPARATION

.1 Prior to start of work under this Section, ensure that the General Trades:

.1 Provide, erect, and maintain temporary barriers at locations indicated.

.2 Erect and maintain weatherproof closures for exterior openings.

.3 Erect and maintain temporary partitions to prevent spread of dust, odours, and noise to permit continued Owner occupancy.

.4 Prevent movement of structure; provide bracing and shoring.

.2 Install, protect and maintain temporary services as required to support continuing operation of the facility.

.3 Protect services and equipment which are not to be demolished.

.4 Coordinate service shutdowns with Owner's project coordinator. Provide notice as required by Owner and submit schedule for the work.

.5 Notify affected utility companies before starting work and comply with their requirements.

.6 Mark location and termination of utilities.

.7 Provide appropriate temporary signage including signage for exit or building egress.

3.2 RELATIONSHIP WITH OTHER TRADES

.1 Cooperate with other trades whose work affects or is affected by work of this Division to ensure satisfactory installation and to avoid delays.

.2 Remove and dispose of built-in items such as sleeves, anchors, and inserts.

.3 Remove and dispose of supports and anchors for piping, mounted on or in walls, supported and suspended from the structure.

3.3 PROTECTION

.1 Protect existing and new work to remain free from damage due to execution of work under this Division with tarpaulins and other protective coverings as necessary.

.2 Repair damage to the building and components resulting from failure to provide sufficient protection, to the satisfaction of the Consultant.

3.4 DEMOLITION

.1 Notify authorities of intent to demolish and schedule for the work.

.2 Conform to codes, regulations, standards and bylaws applicable to the work.

.3 Isolate and drain systems as required. Disconnect, cap and make safe mechanical services to the building including, but not limited to: water supply to sprinkler systems, and fire suppression systems.

.4 Protect existing equipment and services to remain from debris and unwanted materials. Clean as necessary to maintain service during demolition period and on completion of the work.

.5 Coordinate service shutdowns with Owner's project coordinator. Provide notice as required by Owner and submit schedule for the work.

.6 Remove and dispose of all redundant mechanical services and equipment within

the limits of the demolition site and where demolished systems extend beyond these limits.

.7 Conform to Occupational Health & Safety and Environmental regulations. Ensure that all parties are familiar with requirements and experienced in the work to be undertaken.

.8 Conform to the requirements of Division 1, municipal By-Laws and Ministry of the Environment regulations and standards for waste disposal.

.9 Demolish in an orderly and careful manner. Protect existing supporting structural members.

.10 Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.

.11 Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.

.12 Remove temporary Work.

3.5 RENOVATIONS

.1 Isolate and drain systems as required to effect renovations, modifications and/or repairs. On completion of renovations, modifications and/or repairs, test entire system as if new. Report repairs or replacements required of existing equipment, piping, fittings or devices that are not included in contract to Consultant and Owner for instruction. Flush, clean and refill renovated systems as specified for new.

.2 Relocate or remove existing items so designated unless specifically indicated to be relocated or removed under other Sections.

.3 Clear and repair existing items to be relocated or altered as required to suit new location. Replace damaged or ineffective parts and make the item "as new".

.4 Existing items to be removed remain the property of the owner and shall be delivered to a location on site designated by the owner. If the owner declares no interest in the removed items, assume ownership and remove the items from the site.

.5 Make good surfaces and finishes in areas from which items have been removed and in which items are relocated. Cap existing services required to be severed to effect alterations and do all other work necessary to make good such areas to satisfaction of consultant.

.6 Temporarily seal openings in existing floor assemblies and vertical fire separations necessitated by installation of equipment and systems or construction with fire barrier materials such as mineral wool or other noncombustible insulation.

.7 If during alteration work existing asbestos material, other than known asbestos, is discovered (e.g. fireproofing, acoustic or thermal insulation, tank covering), stop work in the affected area and immediately notify consultant.

END OF SECTION

1. GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 21 01 01.

1.2 REFERENCE STANDARDS

.1 National Fire Protection Association (NFPA)

.1 NFPA 10, Standard for Portable Fire Extinguishers.

.2 NFPA 13, Standard for the Installation of Sprinkler Systems.

.3 NFPA 14, Standard for the Installation of Standpipe and Hose Systems.

.4 NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection.

1.3 SHOP DRAWING 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 fire suppression products and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.

.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.

1.4 CLOSEOUT SUBMITTALS

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

.2 Operation and Maintenance Data: submit operation and maintenance data for fire suppression products for incorporation into manual.

.1 Ensure operation and maintenance manual is approved by, and final copies deposited with Consultant before final inspection.

.2 Operation data:

.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:

.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:

.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 draft copy Operation and Maintenance Manual to Consultant for approval. Submission of individual data will not be accepted unless directed by Consultant.

.2 Make changes as required and re-submit as directed by Consultant.

.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 Provide sets of 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 on a weekly basis 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 Consultant 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.

1.5 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 and in accordance with Section 01 78 00 - Closeout Submittals.

.4 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:

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

.2 Store and protect fire protection products from nicks, scratches, blemishes, theft, vandalism and vermin.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal

2. PRODUCTS

2.1 N/A

3. EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate 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 Consultant.

.2 Inform Consultant 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 Consultant.

3.2 PAINTING REPAIRS AND RESTORATION

.1 Do painting in accordance with Section 09 91 23 - Interior Painting.

.2 Prime and touch up marred finished paintwork to match original.

.3 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 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.

3.5 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.

.3 Waste Management: separate waste materials for 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.

3.6 PROTECTION

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

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 21 01 01 General Requirements.

1.2 SECTION INCLUDES

.1 Pipe and equipment hangers and supports.

1.3 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B31.9, Building Services Piping.

.2 American Society for Testing and Materials (ASTM)

.1 ASTM F708, Design and Installation of Rigid Pipe Hangers.

.3 American National Standards Institute (ANSI)

.1 MSS SP58, Pipe Hangers and Supports - Materials, Design and Manufacturer.

.2 MSS SP69, Pipe Hangers and Supports - Selection and Application.

.3 MSS SP89, Pipe Hangers and Supports - Fabrication and Installation Practices.

.4 Underwriters Laboratories (UL)

.1 UL 203, Pipe Hanger Equipment for Fire protection Service.

.5 Canadian Standards Association (CSA)

.1 CSA S832, Seismic Risk Reduction of Operational and Functional Components (OFCs) of Buildings.

.2 CSA B51, Boiler, Pressure Vessel and Pressure Piping Code.

.6 National Fire Protection Association (NFPA)

.1 NFPA 13, Standard for the Installation of Sprinkler Systems.

.2 NFPA 14, Standard for the Installation of Standpipe and Hose Systems.

1.4 SHOP DRAWING SUBMITTALS

.1 See Section 21 01 01 General Requirements for procedures for submittals.

.2 Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

.3 Product Data: Provide manufacturer catalogue data including load capacity.

.4 Design Data: Indicate load carrying capacity of trapeze, multiple pipes, and riser support hangers.

.5 Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.5 REGULATORY REQUIREMENTS

.1 Conform to CSA B51 for support of piping.

.2 Conform to CSA S832 for seismic restraint of piping and equipment.

.3 Conform to NFPA requirements for support of piping and equipment.

.4 Conform to ASME B31.9 requirements for support of piping.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:

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

.1 Store and protect products from nicks, scratches, blemishes, theft, vandalism and vermin.

.5 Replace defective or damaged materials with new.

.6 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal

2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

.1 Manufacturers:

.1 Anvil

.2 Sprinkler Piping:

.1 Hangers for Pipe Sizes 1/2" to 1-1/2" (13 to 38 mm): Carbon steel, adjustable swivel, split ring.

.2 Hangers for Cold Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.

.3 Hangers for Hot Pipe Sizes 2" to 4" (50 to 100 mm): Carbon steel, adjustable, clevis.

.4 Multiple or Trapeze Hangers: Steel channels with welded spacers and

hanger rods.

2.2 ACCESSORIES

.1 Hanger Rods: galvanized, carbon steel continuous threaded.

.2 Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

3 EXECUTION

3.1 INSTALLATION

.1 Install according to manufacturer's instructions and best trade practices.

3.2 INSERTS

.1 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

.2 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

.3 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

3.3 PIPE HANGERS AND SUPPORTS

.1 Support horizontal piping as scheduled.

.2 Install hangers to provide minimum 1/2" (13 mm) space between finished covering and adjacent work.

.3 Place hangers within 12" (300 mm) of each horizontal elbow.

.4 Use hangers with 1-1/2" (38 mm) minimum vertical adjustment.

.5 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

.6 Design hangers for pipe movement without disengagement of supported pipe.

.7 Prime coat exposed steel hangers and supports. Hangers and supports located in suspended ceiling spaces are not considered exposed.

3.4 SCHEDULES

.1 Imperial Measure (IP)

Pipe Size (in)	Rod Diameter (in)	Support Spacing (Ft)	
		Steel Pipe	Copper

			Tube
1/2	3/8	7	6
¾	3/8	7	6
1	3/8	7	6
1-1/4	3/8	7	6
1-1/2	3/8	9	8
2	3/8	10	9
2-1/2	3/8	12	10
3	3/8	12	10

.2 Metric Measure (SI)

Pipe Size (mm)	Rod Diameter (mm)	Support Spacing (m)	
		Steel Pipe	Copper Tube
13	10	2.1	1.8
20	10	2.1	1.8
25	10	2.1	1.8
32	10	2.1	1.8
38	10	2.7	2.4
50	10	3	2.7
65	10	3.6	3
75	10	3.6	3

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 21 01 01 General Requirements.

1.2 REFERENCE STANDARDS

.1 Factory Mutual (FM)

.1 FM - Factory Mutual System - Approval Guide.

.2 National Fire Protection Association (NFPA)

.1 NFPA 10 - Portable Fire Extinguishers.

.3 Underwriters Laboratories Canada (ULC)

.1 ULC - Fire Protection Equipment Directory.

.4 Standards Council of Canada (SCC)

.1 CAN/ULC S508, "Rating and Fire Testing of Fire Extinguishers".

1.3 SHOP DRAWING SUBMITTALS

.1 Refer to Section 21 01 01 General Requirements.

.2 Product Data: Provide manufacturers literature including general assembly, type and rating.

1.4 CLOSEOUT SUBMITTALS

.1 Refer to Section 21 01 01 General Requirements.

.2 Project Record Documents: Record actual locations of components and accessories.

.3 Maintenance Data: Include manufacturers literature, cleaning procedures, replacement parts lists.

1.5 QUALITY ASSURANCE

.1 Perform Work to NFPA 10

.2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.6 REGULATORY REQUIREMENTS

.1 ULC listed and labelled

.2 Rated and identified in conformance with CAN/ULC S508, "Rating and Fire Testing of Fire Extinguishers".

1.7 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:

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

.2 Store and protect fire protection products from nicks, scratches, blemishes, theft, vandalism and vermin.

.4 Replace defective or damaged materials with new.

.5 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal

2 PRODUCTS

2.1 GENERAL

.1 Manufacturers

.1 National Fire Equipment

.2 Kent

2.2 MULTI-PUPURPOSE DRY CHEMICAL

.1 Type: multi-purpose (ABC) type, dry chemical

.2 Size: 5 lb. (2.27 kg)

.3 Rating: minimum 3A:10BC

2.3 CABINETS

.1 Fully Recessed – Not Fire Rated

.1 Tub: 22 ga. steel.

.2 Door & Trim: galvanneal steel with white powder-coated painted finish.

.3 Size: to accommodate specified extinguisher

.4 Inside box dimensions: To suit fire extinguisher.

.5 Door Style: Glazing – Clear Tempered Safety Glass.

.6 Manufacturer: National Fire Equipment Ltd.

.2 Fully Recessed – Fire Rated

.1 Tub: Cold rolled steel with fire insulation material and electrostatically-

applied thermally fused polyester coating with re-coatable white finish and continuous hinge.

.2 Door and Frame: Galvannealed steel with recoatable white powder-coated finish

.3 Manufacturer: National Fire Equipment Ltd.

.3 In mechanical and electrical rooms, provide wall hanger bracket.

3 EXECUTION

3.1 INSTALLATION

.1 Follow manufacturer's instructions.

.2 Conform to NFPA 10.

.3 Locate and secure cabinets plumb and level. Establish top of cabinet (inside horizontal surface) 65" (1675 mm) above finished floor.

.4 Locate fire extinguisher in cabinet as indicated.

.5 Install with wall mounting bracket where not installed in cabinets.

3.2 APPLICATIONS

.1 Provide fire extinguishers where indicated and in conformance with the Ontario Fire Code and NFPA 10.

END OF SECTION

1. GENERAL

1.1 GENERAL REQUIREMENTS

.1 Refer to Section 21 01 01.

1.1 REFERENCE STANDARDS

.1 National Fire Prevention Association (NFPA)

.1 NFPA 13-2019, Standard for the Installation of Sprinkler Systems.

.2 NFPA 20-2019, Standard for the Installation of Stationary Pumps for Fire Protection.

.3 NFPA 24-2019, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

.4 NFPA 25-2020, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.

.2 Underwriter's Laboratories of Canada (ULC)

.1 CAN4 S543-M984, Standard for Internal Lug Quick Connect Couplings for Fire Hose.

.2 ULC/ORD C263.1, Sprinkler Protected Window Systems.

.3 ULC Fire Resistance Directory.

.3 Underwriters Laboratory (UL)

.1 UL 199, Automatic Sprinklers for Fire-Protection Service.

.4 Factory Mutual (FM)

.1 Factory Mutual Approval Guide.

.5 American Society of Testing and Materials (ASTM)

.1 ASTM A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

.2 ASTM B61, Standard Specification for Steam or Valve Bronze Castings.

.3 ASTM B62, Standard Specification for composition Bronze or Ounce Metal Castings.

.4 ASTM A126, Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.

.5 ASTM B283 C37700, Standard Specification for Copper and Copper-Alloy Die Forgings (Hot Pressed).

.6 American Society of Mechanical Engineers (ASME)

.1 ASME B16.1, Gray Iron Pipe Flanges & Flanged Fittings Class 25, 125 & 250.

.2 ASME B16.3, Malleable Iron Threaded Fittings, Classes 150 and 300.

.3 ASME B16.4, Gray Iron Threaded Fittings, Classes 125 and 250.

.4 ASME B16.9, Factory-Made Wrought Buttwelding Fittings.

.5 ASME B16.10, Face-to-Face and End-to-End Dimensions of Valves.

.6 ASME B16.15, Cast Copper Alloy Threaded Fittings: Classes 125 and 250.

.7 ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.

.8 ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.

.9 ASME B16.39, Malleable Iron Threaded Pipe Unions: Classes 150, 250 and 300.

.7 American Water Works Association (AWWA)

.1 AWWA C104, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.

.2 AWWA C105, Polyethylene Encasement for Ductile-Iron Pipe Systems.

.3 AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.4 AWWA C115, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.

.5 AWWA C150, Thickness Design of Ductile-Iron Pipe.

.6 AWWA C151, Ductile-Iron Pipe, Centrifugally Cast.

.7 AWWA C600, Standard for the Installation of Ductile Iron Water Mains and Their Appurtenances.

.8 Manufacturers Standardization Society of Valve and Fittings Industry (MSS)

.1 MSS-SP-25, Standard Marking Systems for Valves, Fittings, Flanges, and Unions.

.2 MSS-SP-67, Butterfly Valves.

.3 MSS-SP-70, Gray Iron Gate Valves, Flanged and Threaded Ends.

.4 MSS-SP-71, Gray Iron Swing Check Valves, Flanged and Threaded Ends.

.5 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.

.6 MSS-SP-85, Gray Iron Globe & Angle Valves, Flanged and Threaded Ends.

1.2 SHOP DRAWING SUBMITTALS

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

.2 Product Data:

.1 Provide manufacturer's printed product literature and data sheets, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario.

.2 Indicate:

.1 Materials.

.2 Finishes.

.3 Method of anchorage

.4 Number of anchors.

.5 Supports.

.6 Reinforcement.

.7 Assembly details.

.8 Accessories.

.4 Layout Drawings:

.1 Show finished ceiling areas indicating sprinkler locations coordinated with ceiling installation.

.2 Indicate the following:

.3 Name and department or agency

.4 Location, including street address.

.5 Point of compass

.6 Ceiling construction.

.7 Full height cross section.

.8 Location of fire walls.

.9 Occupancy of each area or room.

.10 Location and size of blind spaces and closets.

.11 Any questionable small enclosures in which no sprinklers are to be installed.

.12 Make, type and orifice size of sprinklers.

.13 Temperature rating and location of high temperature sprinklers.

.14 Number of sprinklers on each zone, and total area protected by each zone.

.15 Make, type, model and size of alarm valves.

.16 Cutting lengths of pipe or centre to centre dimensions.

.17 Type of hangers, inserts and sleeves.

.18 Control valves, checks, drain pipes and test pipes.

.19 Provisions for flushing.

.20 Name and address of contractor

.21 A summary sheet, clearly indicating:

.1 Date.

.2 Location.

.3 Name of department of agency.

.4 Building number or other identification.

.5 Description of hazard.

.6 Name and address of contractor or designer.

.7 Name of approving agency.

.8 System design requirements, including design area of water application, minimum rate of application and area per sprinkler.

.5 Samples:

.1 Submit samples of following:

.1 Each type of sprinkler head.

.2 Signs.

.6 Test reports:

.1 Submit certified test reports for wet pipe fire protection sprinkler systems from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

.7 Certificates:

.1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.8 Manufacturers' Instructions:

.1 Provide manufacturer's installation instructions.

.9 Field Quality Control Submittals:

.1 Manufacturer's Field Reports: manufacturer's field reports specified.

1.3 CLOSEOUT SUBMITTALS

.1 Provide operation, maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals in accordance with ANSI/NFPA 20.

.2 Manufacturer's catalogue Data, including specific model, type, and size for:

- .1 Pipe and fittings.
- .2 Alarm valves.
- .3 Valves, including gate, check, and globe.
- .4 Water motor alarms.
- .5 Sprinkler heads.
- .6 Pipe hangers and supports.
- .7 Pressure or flow switch.
- .8 Fire department connections.
- .9 Excess pressure pump.
- .10 Mechanical couplings.

.3 Drawings:

- .1 Sprinkler heads and piping system layout.
  - .1 Prepare 760 mm by 1050 mm detail working drawings of system layout in accordance with NFPA 13, "Working Drawings (Plans)".
  - .2 Show data essential for proper installation of each system.
  - .3 Show details, plan view, elevations, and sections of systems supply and piping.
  - .4 Show piping schematic of systems supply, devices, valves, pipe, and fittings. Show point to point electrical wiring diagrams.
- .2 Electrical wiring diagrams.

.4 Design Data:

- .1 Calculations of sprinkler system design.
- .2 Indicate type and design of each system and certify that each system has performed satisfactorily in the manner intended for not less than 18 months.

.5 Field Test Reports:

- .1 Preliminary tests on piping system.

.6 Records:

- .1 As-built drawings of each system.
  - .1 After completion, but before final acceptance, submit complete set of as-built drawings of each system for record purposes.

.2 Submit 760 mm by 1050 mm drawings on reproducible media.

.7 Operation and Maintenance Manuals:

.1 Provide detailed hydraulic calculations including summary sheet, and Contractors Material and Test Certificate for aboveground and underground piping and other documentation for incorporation into manual in accordance with NFPA 13.

1.4 QUALITY ASSURANCE

.1 Qualifications:

.1 Installer: company or person specializing in wet sprinkler systems with documented experience approved by manufacturer.

.2 Supply grooved joint couplings, fittings, valves, grooving tools and specialties from a single manufacturer. Use date stamped castings for coupling housings, fittings, valve bodies, for quality assurance and traceability.

1.5 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials:

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

.2 Provide spare sprinklers and tools in accordance with NFPA 13.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Storage and Protection:

.1 Store materials indoors, in dry location.

.2 Store and protect materials from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

2. PRODUCTS

2.1 DESIGN REQUIREMENTS

.1 Design automatic wet pipe fire suppression sprinkler systems in accordance with required and advisory provisions of NFPA 13, by hydraulic calculations for uniform distribution of water over design area.

.2 Include with each system materials, accessories, and equipment inside and outside building to provide each system complete and ready for use.

.3 Design and provide systems to account for blind spaces, piping, electrical equipment, ducts, and other construction and equipment in accordance with detailed shop drawings.

.4 Locate sprinkler heads in consistent pattern with ceiling grid, lights, and air supply diffusers.

.5 Devices and equipment for fire protection service: ULC approved for use in wet pipe sprinkler systems.

.6 Design systems for earthquake protection as required by seismic zone and building classification.

.7 Location of Sprinkler Heads:

.1 Locate heads in relation to reflected ceiling plan. Ensure spacing of sprinkler heads does not exceed that permitted by NFPA 13.

.2 Uniformly space sprinklers on branch.

.8 Water Distribution:

.1 Make distribution uniform throughout the area in which sprinkler heads will open.

.2 Discharge from individual heads in hydraulically most remote area to be 100 % of specified density.

.9 Density of Application of Water:

.1 Size pipe to provide specified density when system is discharging specified total maximum required flow.

.10 Sprinkler Discharge Area:

.1 Area: hydraulically most remote area as defined in NFPA 13.

.11 Outside Hose Allowances:

.1 Include allowance in hydraulic calculations of for outside hose streams as required.

.12 Friction Losses:

.1 Calculate losses in piping in accordance with Hazen-Williams formula with 'C' value of 120 for steel piping, 150 for copper tubing, and 140 for cement-lined ductile-iron piping.

.13 Water Supply:

.1 Base hydraulic calculations on static pressure and residual water pressure available at design flow as per hydrant test reports provided.

2.2 ABOVE GROUND PIPING SYSTEMS

.1 Provide fittings for changes in direction of piping and for connections.

.1 Make changes in piping sizes through tapered reducing pipe fittings, bushings will not be permitted.

.2 Conceal piping in areas with suspended ceilings.

2.3 PIPE AND FITTINGS

.1 Steel Pipe: ASTM A53B.

.1 Joined by welding or by roll grooved pipe and fittings:

.1 schedule 10 for sizes 5" (125mm) and smaller,

.2 0.134" (3.40mm) for 6" (150mm) diameter,

.3 0.188" (4.78mm) for 8" and 10" (200mm and 250mm) diameter.

.2 Joined with threaded fittings or cut groove pipe and fittings:

.1 schedule 40 for sizes 6" (150mm) diameter and smaller,

.2 schedule 30 for sizes 8" (200mm) diameter and larger.

.2 Copper tube: to NFPA 13.

.3 Fittings and joints to NFPA 13:

.1 Ferrous: screwed, welded, flanged or roll grooved.

.1 Grooved joints designed with two ductile iron housing segments, pressure responsive gasket, and zinc-electroplated steel bolts and nuts. Cast with offsetting angle-pattern bolt pads for rigidity and visual pad-to-pad offset contact.

.2 Steel Fittings: ASME B16.9, wrought steel, buttwelded.

.3 Cast Iron Fittings: ASME B16.1, flanges and flanged fittings.

.4 Malleable Iron Fittings: ASME B16.39, threaded fittings.

.5 Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.

.6 Mechanical Formed Fittings: Carbon steel housing with integral pipe stop and O-ring pocket and O-ring uniformly compressed into permanent mechanical engagement onto pipe.

.2 Copper tube: screwed, soldered, brazed, grooved.

.3 Plain-end fittings with mechanical couplings and fittings which use steel gripping devices to bite into pipe when pressure is applied will not be permitted.

.4 Rubber gasketed grooved-end pipe and fittings with mechanical couplings are permitted in pipe sizes 32 mm and larger.

.5 Fittings: ULC approved for use in wet pipe sprinkler systems.

.6 Ensure fittings, mechanical couplings, and rubber gaskets are supplied by same manufacturer.

.7 Side outlet tees using rubber gasketed fittings are not permitted.

.8 Sprinkler pipe and fittings: metal.

2.4 VALVES

.1 Provide cUL or ULC and FM approved, listed and labelled.

.2 Provide listed indicating valves for controlling connections to water supplies.

.3 Conform to requirements of ANSI, ASTM, ASME, and applicable MSS standards.

.4 Provide valves of the same manufacturer where possible.

.5 Ensure manufacturer's name and pressure rating clearly marked on body to MSS-SP-25.

.6 Provide valves and fittings with valid Canadian Registration Number for the Province of Ontario. Indicate CRN on submittals.

.7 Isolation Valves:

.1 ULC listed for fire protection service. Electrically Supervised: ULC listed, FM approved, NO/NC SPDT dry contact switch suitable for electrical supervision on trouble circuit of facility fire alarm system. Valve monitoring switches shall be Potter Electric Signal and Manufacturing Limited or equivalent.

.8 Gate valves: open by counterclockwise rotation.

.1 Up to 2”: ULC listed, FM approved, Class 300, non-shock WOG, ASTM B62 bronze body, solid wedge disc, rising stem, bronze trim, threaded ends.

.2 2-1/2” and larger: ULC listed, FM approved, Class 175, CWP, outside screw and yoke, cast iron body, stem with ACME double threads, tapered solid wedge disc, flanged ends, renewable bronze seat rings.

.9 Provide valves beneath each alarm valve in each riser when more than one alarm valve is supplied from same water supply pipe.

.10 Check valves: flanged clear opening swing or spring actuated check type with flanged inspection and access cover plate for sizes 4” and larger.

.11 Provide gate valve in piping protecting elevator hoist ways, machine rooms, and machinery spaces.

.12 Drain Valves:

.1 ULC listed and FM approved, brass ball valve with cap and chain, 3/4" (20 mm) hose thread.

2.5 PIPE HANGERS AND SUPPORTS

.1 ULC listed for fire protection services in accordance with NFPA 13.

.2 Hangers for Pipe Sizes 1/2" to 1-1/2" (15 to 40 mm): Carbon steel, adjustable swivel, split ring.

.3 Hangers for Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.

.4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

.5 Wall Support for Pipe Sizes to 3-1/4" (80 mm): Cast iron hook.

.6 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.

.7 Vertical Support: Steel riser clamp.

.8 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

2.6 SPRINKLER HEADS

.1 General: to NFPA 13 and ULC listed for fire services.

.2 Sprinkler Head Type:

.1 Standard Upright:

.1 Type: Standard upright type with guard.

.2 Finish: Brass.

.3 Fusible Link: Glass bulb type temperature rated for specific area hazard.

.2 Dry Sprinklers Concealed Pendant:

.1 Type: Concealed pendant standard response dry sprinkler concealed escutcheon.

.2 Sprinkler Frame Finish: Plain Brass.

.3 Deflector: Brass

.4 Escutcheon Plate Finish: White Polyester Painted.

.5 Cover plate attachment with 1/2" (13mm) assembly adjustment.

.3 Concealed Pendant:

.1 Type: Adjustable concealed standard spray pendant.

.2 Sprinkler Frame Finish: Plain Brass.

.3 Deflector: Bronze per UNS C22000.

.4 Cover plate: Brass per UNS C26000. Factory painted (confirm colour with architect prior to ordering)

.5 Cover plate attachment with 1/2" (13mm) assembly adjustment.

.6 Smooth aesthetic ceiling profile.

.7 Factory installed protective cap.

.4 Concealed Sidewall Pendant:

.1 Type: concealed sidewall standard spray sprinkler.

.2 Sprinkler Frame Finish: Brass UNS-C31400

.3 Seat: Brass UNS-C31400

.4 Deflector: Brass per UNS C23000.

.5 Shipping Cap: Polyethylene

.6 Cover plate: Brass per UNS C26000. Factory painted (confirm colour with architect prior to ordering). Nickel alloy spring and eutectic solder.

.7 Cover plate attachment with 1/2" (13mm) assembly adjustment.

.8 Smooth aesthetic ceiling profile.

.9 Factory installed protective cap.

.5 Concealed Sidewall Pendant:

.1 Type: horizontal sidewall window sprinkler

.2 c(UL) listed

.3 Discharge coefficient: 5.6 GPM/PSI

.4 Finish: Chrome Plated

.5 Frame: Brass

.6 Button: Bronze

.7 Sealing Assembly: Beryllium Nickel w/ TEFLON

.8 Bulb: Glass

.9 Deflector: Bronze

.6 Guards: Finish to match sprinkler finish.

.3 Provide nominal 1.2 cm orifice sprinkler heads.

.1 Provide higher temperature release elements as required for specific applications/

.2 Provide polished stainless steel ceiling plates or chromium-plated finish on copper alloy ceiling plates, and chromium-plated pendent] sprinklers below suspended ceilings.

.3 Provide corrosion-resistant sprinkler heads and sprinkler head guards in accordance with NFPA 13.

.4 Deflector: not more than 75 mm below suspended ceilings.

.5 Ceiling plates: not more than 25 mm deep.

.6 Ceiling cups: not permitted.

2.7 ALARM CHECK VALVE

.1 Alarm check valve to NFPA 13 and ULC listed for fire service.

.2 Provide variable pressure type alarm valve complete with retarding chamber, alarm test valve, alarm shutoff valve, drain valve, pressure gauges, accessories, and appurtenances for proper operation of system.

.3 Provide valve complete with internal components that are replaceable without removing the valve from the installed position.

2.8 WATER MOTOR ALARMS

.1 Provide alarms approved weatherproof and guarded type, to sound locally on flow of water in each corresponding sprinkler system.

.2 Mount alarms on outside of outer walls of each building at location as directed.

.3 Provide separate drain piping directly to exterior of building.

2.9 SUPERVISORY SWITCHES

.1 General: to NFPA 13 and ULC listed for fire service.

.2 Valves:

.1 Mechanically attached to valve body, with normally open and normally closed contacts and supervisory capability.

.3 Pressure or flow switch type:

.1 With normally open and normally closed contacts and supervisory capability.

.2 Provide switch with circuit opener or closer for automatic transmittal of alarm over facility fire alarm system.

.3 Connect into building fire alarm system.

.4 Connection of switch: Section 28 31 00 - Fire Detection and Alarm.

.5 Alarm actuating device: mechanical diaphragm controlled retard device adjustable from 10 to 60 seconds and instantly recycle.

.4 Pressure alarm switch:

.1 With normally open and normally closed contacts and supervisory capability.

2.10 WATER GONG

.1 To NFPA 13 and ULC listed for fire service. Location as indicated.

2.11 FIRE DEPARTMENT CONNECTION

.1 Provide connections approximately 1.5 m above finish grade, location as indicated.

.2 To NFPA 13 and ULC S543 listed, Siamese type.

.3 Polished chrome plated recessed exposed of approved two-way type with 2.5 inch National Standard female hose threads with plug, chain, and identifying fire department connection escutcheon plate.

.4 Thread specifications: compatible with local fire department.

.5 Install a 90-degree elbow with drain connection at the low-point near each fire department connection to allow for system drainage to prevent freezing.

2.12 EXCESS PRESSURE PUMP

.1 Provide pumps on each sprinkler piping riser.

.2 Pumps:

.1 Pumps: positive displacement, gear type, integrally mounted with motor.

.2 Double acting displacement type, open cylinder design, direct drive, ULC listed, complete with relief valve.

.3 Pump and motor unit:

.1 Approved for automatic wet pipe fire extinguishing sprinkler systems; complete with pilot light panel, differential motor control switch, high pressure switch, and low pressure switch.

.2 EEMAC Class B squirrel cage induction 1725 rpm, continuous duty, drip proof, ball bearing, maximum temperature rise 50 degrees C, 120/1/60.

.4 Provide electrical power supply connections for pump and pilot light panel at supply side of building service panel.

.5 Provide separate fused safety-type switch with locked lever for each connection.

.6 Provide pressure pump sensing piping in supply piping upstream of fire pump.

.7 Pump operation switch: to operate excess pressure pump with pressure differential of 103 kPa.

.8 Shut-off valve and strainer on pump inlet. Relief valve, check valve and shut-off valve on discharge connections.

2.13 PRESSURE GAUGES

.1 ULC listed and to Section 23 05 19.13 - Thermometers and Pressure Gauges - Piping Systems.

.2 Maximum limit of not less than twice normal working pressure at point where installed.

2.14 PIPE SLEEVES

.1 Provide pipe sleeves where piping passes through walls, floors, and roofs.

.2 Secure sleeves in position and location during construction.

.3 Provide sleeves of sufficient length to pass through entire thickness of walls, floors, and roofs.

.4 Provide 2.5 cm minimum clearance between exterior of piping and interior of sleeve or core-drilled hole.

.1 Firmly pack space with mineral wool insulation.

.2 Seal space at both ends of sleeve or core-drilled hole with mechanically adjustable segmented elastomeric seal.

.3 In fire walls and fire floors, seal both ends of pipe sleeves or core-drilled holes with ULC listed fill, void, or cavity material.

.5 Sleeves in Masonry and Concrete Walls, Floors, and Roofs:

.1 Provide hot-dip galvanized steel.

.2 Core drilling of masonry and concrete may be provided in lieu of pipe sleeves when cavities in core-drilled hole are completely grouted smooth.

.6 Sleeves in Other Than Masonry and Concrete Walls, Floors, and Roofs:

.1 Provide 0.61 mm thick galvanized steel sheet.

2.15 ESCUTCHEON PLATES

.1 Provide one piece type metal plates for piping passing through walls, floors, and ceilings in exposed spaces.

.2 Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces.

.3 Provide paint finish on metal plates in unfinished spaces.

2.16 INSPECTOR'S TEST CONNECTION

.1 Locate inspector's test connection at hydraulically most remote part of each system, provide test connections approximately 3 m above floor for each sprinkler system or portion of each sprinkler system equipped with alarm device.

.2 Provide test connection piping to location where discharge will be readily visible and where water may be discharged without property damage.

.3 Provide discharge orifice of same size as corresponding sprinkler orifice.

2.17 SIGNS

.1 Attach properly lettered and approved metal signs to each valve and alarm device to NFPA 13.

.2 Permanently fix hydraulic design data nameplates to riser of each system.

2.18 ANTIFREEZE

.1 Antifreeze loops to NFPA 13, locations as indicated.

2.19 SPARE PARTS CABINET

.1 Provide metal cabinet with extra sprinkler heads and sprinkler head wrench adjacent to each alarm valve. Number and types of extra sprinkler heads as specified in NFPA 13.

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, inspect and test to acceptance in accordance with NFPA 13 and NFPA 25.

3.3 PIPE INSTALLATION

.1 Install piping straight and true to bear evenly on hangers and supports. Do not hang piping from plaster ceilings.

.2 Keep interior and ends of new piping and existing piping thoroughly cleaned of water and foreign matter.

.3 Keep piping systems clean during installation by means of plugs or other approved methods. When work is not in progress, securely close open ends of piping to prevent entry of water and foreign matter.

.4 Inspect piping before placing into position.

.5 Ream pipe and tube ends. Remove burrs.

.6 Remove scale and foreign material, from inside and outside, before assembly.

.7 Prepare piping connections to equipment with flanges or unions.

.8 Install piping to conserve building space, to not interfere with use of space and other work.

.9 Sleeve pipes passing through partitions, walls, and floors.

.10 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

3.4 PIPE HANGERS AND SUPPORTS

.1 Install hangers to provide minimum 1/2" (15 mm) space between finished covering and adjacent work.

.2 Place hangers within 12" (300 mm) of each horizontal elbow.

.3 Use hangers with 1-1/2" (40 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

.4 Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.

.5 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

.6 Provide copper plated hangers and supports for copper piping.

3.5 VALVES AND FITTINGS

.1 Install valves with stems upright or horizontal, not inverted. Remove protective coatings prior to installation.

.2 Provide ball valves for shut-off or isolating service.

.3 Provide drain valves at main shut-off valves, low points of piping and apparatus.

.4 Provide control, drain and test connection valves with permanently engraved and marked weatherproof metal or rigid plastic identification signs, secured with weather resistant chain or other approved method.

.5 Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

.6 When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.6 ELECTRICAL CONNECTIONS

.1 Provide electrical work associated with this section under Section 26 05 00 - Common Work Results for Electrical.

.2 Provide fire alarm system under Section 28 31 00 - Fire Detection and Alarm.

.3 Provide control and fire alarm wiring, including connections to fire alarm systems, in accordance with National Electrical Code.

.4 Provide wiring in rigid metal conduit or intermediate metal conduit.

3.7 DISINFECTION

.1 Disinfect new piping and existing piping.

.2 Fill piping systems with solution containing minimum of 50 parts per million of chlorine and allow solution to stand for minimum of 24 hours.

.3 Flush solution from systems with clean water until maximum residual chlorine content is not greater than 0.2 part per million or residual chlorine content of domestic water supply.

.4 Obtain at least two consecutive satisfactory bacteriological samples from piping, analyzed by certified laboratory, and submit results prior to piping being placed into service.

3.8 CONNECTIONS TO EXISTING WATER SUPPLY SYSTEMS

.1 Notify Contracting Officer in writing at least 15 days prior to connection date.

.2 Use tapping or drilling machine valve and mechanical joint type sleeves for connections to be made under pressure.

.3 Bolt sleeves around main piping.

.4 Bolt valve to branch connection. Open valve, attach drilling machine, make tap, close valve, and remove drilling machine, without interruption of service.

.5 Furnish materials required to make connections into existing water supply systems, and perform excavating, backfilling, and other incidental labour as required.

3.9 BURIED PIPING SYSTEM

.1 Bury tape with printed side up at depth of 30 cm below the top surface of earth or top surface of subgrade under pavements.

3.10 FIELD PAINTING

.1 Clean, pretreat, prime, and paint new systems including valves, piping, conduit, hangers, supports, miscellaneous metalwork, and accessories.

.2 Apply coatings to clean, dry surfaces, using clean brushes.

.3 Clean surfaces to remove dust, dirt, rust, and loose mill scale.

.4 Immediately after cleaning, provide metal surfaces with 1 coat of pretreatment primer applied to minimum dry film thickness of 0.3 ml, and one coat of zinc chromate primer applied to minimum dry film thickness of 1.0 ml.

.5 Shield sprinkler heads with protective covering while painting is in progress.

.6 Upon completion of painting, remove protective covering from sprinkler heads.

.7 Remove sprinkler heads which have been painted and replace with new sprinkler heads.

.8 Provide primed surfaces with following:

.1 Piping in Finished Areas:

.1 Provide primed surfaces with 2 coats of paint to match adjacent surfaces.

.2 Provide valves and operating accessories with 1 coat of red alkyd gloss enamel applied to minimum dry film thickness of 1.0 mil.

.3 Provide piping with 50 mm wide red enamel bands spaced at maximum of 6 m intervals throughout piping systems.

.2 Piping in Unfinished Areas:

.1 Provide primed surfaces with one coat of red alkyd gloss enamel applied to minimum dry film thickness of 1.0 mil in attic spaces, spaces above suspended ceilings, crawl spaces, pipe chases, mechanical equipment room, and spaces where walls or ceiling are not painted or not constructed of a prefinished material.

3.11 FIELD QUALITY CONTROL

.1 Site Test, Inspection:

.1 Perform test to determine compliance with specified requirements in presence of Consultant.

.2 Test, inspect, and approve piping before covering or concealing.

.3 Preliminary Tests:

.1 Hydrostatically test each system at 200 psig for a 2 hour period with no leakage or reduction in pressure.

.2 Flush piping with potable water in accordance with NFPA 13.

.3 Piping above suspended ceilings: tested, inspected, and approved before installation of ceilings.

.4 Test alarms and other devices.

.5 Test water flow alarms by flowing water through inspector's test connection. When tests have been completed and corrections made, submit signed and dated certificate in accordance with NFPA 13.

.4 Formal Tests and Inspections:

.1 Do not submit request for formal test and inspection until preliminary test and corrections are completed and approved.

.2 Submit written request for formal inspection at least 15 days prior to inspection date.

.3 Repeat required tests as directed.

.4 Correct defects and make additional tests until systems comply with contract requirements.

.5 Furnish appliances, equipment, instruments, connecting devices, and personnel for tests.

.6 Authority of Jurisdiction, will witness formal tests and approve systems before they are accepted.

.2 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 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

.3 Site Tests:

.1 Field test fire pump, driver and controllers in accordance with NFPA 20:

.1 Verification of proper installation system initiation adjustment and fine tuning.

.2 Verification of the sequence of operations and alarm systems.

.2 Testing to be witnessed by authority having jurisdiction.

.3 Develop, with Consultant assistance, detailed instructions for O & M of this installation.

3.12 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 recycling in accordance with Section 01 74 19 - Waste Management and Disposal .

END OF SECTION

1. GENERAL

1.1 GENERAL REQUIREMENTS

.1 Refer to Section 21 01 01.

1.1 REFERENCE STANDARDS

.1 National Fire Protection Association (NFPA)

.1 NFPA13, Standard for the Installation of Sprinkler Systems.

.2 NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.

.2 Underwriter's Laboratories of Canada (ULC)

.1 CAN4 S543, Standard for Internal Lug Quick Connect Coupling for Fire Hose.

1.2 SHOP DRAWING SUBMITTALS

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

.2 Product Data:

.1 Provide manufacturer's printed product literature and data sheets for equipment and systems, applicable series designation or style and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario.

.4 Samples:

.1 Submit samples of following:

.1 Each type of sprinkler head.

.2 Signs and valve tags.

.5 Test reports:

.1 Submit certified test reports for packaged fire pumps from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

.2 Test each pump/driver package at factory to provide detailed performance data and to demonstrate compliance with NFPA and specification. Submit certified test curves for approval of Consultant.

.3 Test hydrostatically to meet requirements of fire protection system to which it will be connected.

.6 Certificates:

.1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.7 Manufacturers' Instructions:

.1 Instructions: provide manufacturer's installation instructions.

.8 Field Quality Control Submittals:

.1 Manufacturer's Field Reports: submit manufacturer's field reports specified.

1.3 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

.2 Provide detailed hydraulic calculations including summary sheet, Contractor's Material and Test Certificate for aboveground and underground piping, as well as other deliverables for incorporation into manual specified in Section 01 78 00 - Closeout Submittals, in accordance with NFPA 13.

1.4 QUALITY ASSURANCE

.1 Qualifications:

.1 Installer: company or person specializing in dry sprinkler systems with documented experience approved by manufacturer.

.2 Supply grooved joint couplings, fittings, valves, grooving tools and specialties from a single manufacturer. Use date stamped castings for coupling housings, fittings, valve bodies, for quality assurance and traceability.

1.5 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials:

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

.2 Provide spare sprinklers and tools in accordance with NFPA 13.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

2. PRODUCTS

2.1 ENGINEERING DESIGN CRITERIA

.1 Design system in accordance with NFPA 13, using following parameters:

.1 Hazard:

.1 To suit occupancy as indicated.

.2 Pipe size and layout:

.1 Hydraulic design

.2 Sprinkler head layout: to NFPA 13.

.3 Water supply:

.1 Conduct flow and pressure test of water supply in vicinity of project to obtain criteria for bases of design in accordance with NFPA 13.

.4 Zoning:

.1 System zoning as indicated.

2.2 PIPE, FITTINGS AND VALVES

.1 Pipe:

.1 Ferrous: to NFPA 13.

.2 Copper tube: to NFPA 13.

.2 Fittings and joints to NFPA 13:

.1 Ferrous: screwed, welded, flanged or roll grooved.

.1 Grooved joints designed with two ductile iron housing segments, flush seal gasket for dry service, and zinc-electroplated steel bolts and nuts. Cast with offsetting angle-pattern bolt pads for rigidity and visual pad-to-pad offset contact.

.2 Copper tube: screwed, soldered, brazed, or grooved.

.3 Auxiliary valves:

.1 ULC listed for fire protection service.

.2 Up to NPS 2: bronze, screwed ends, grooved, OS & Y gate.

.3 NPS 2 1/2 and over: cast or ductile iron, flanged or roll grooved ends, indicating butterfly valve.

.4 Swing or spring-actuated check valves.

.5 Ball drip.

.6 Tamper devices wired back to fire alarm panel.

.4 Pipe hangers:

.1 ULC listed for fire protection services.

2.3 SPRINKLER HEADS

.1 General: to NFPA 13 and ULC listed for fire services.

2.4 AUXILIARY SUPERVISORY SWITCHES

.1 General: to NFPA 13 and ULC listed for fire service.

.2 Valves:

.1 Mechanically attached to valve body, with normally open and normally closed contacts and supervisory capability.

.3 Flow switch type:

.1 With normally open and normally closed contacts and supervisory capability.

.4 Pressure alarm switch:

.1 With normally open and normally closed contacts and supervisory capability.

2.5 WATER GONG

.1 To NFPA 13 and ULC listed for fire service. Location as indicated.

2.6 DRY PIPE VALVE

.1 ULC listed.

.2 Cast or ductile iron, flanged or grooved end type, sized to suit water main.

.3 Components:

.1 Accelerator.

.2 Air maintenance device with low pressure alarm.

.3 Alarm pressure switch with supervisory capability.

.4 Pressure gauges.

.5 Drain valve.

.6 Test valve with associated piping.

.7 Shut off valve - OS & Y with tamper-proof device wired back to fire alarm panel.

.8 Required air pressure 90 kPa (13 psi).

.4 Provide valve complete with internal components that are replaceable without removing valve from installed position.

2.7 PRE-ACTION /DELUGE ALARM VALVE

.1 ULC listed.

.2 Cast or ductile iron, flanged or grooved end type, sized to suit water main.

.3 Components:

.1 Accelerator.

.2 Air maintenance device with low pressure alarm.

.3 Alarm pressure switch with supervisory capability.

.4 Test valve and associated piping.

.5 Drain valve.

.6 Electrical tripping device.

.7 Shut off valve - OS & Y with tamper-proof device wired back to fire alarm panel.

.4 Provide valve complete with internal components that are replaceable without removing valve from installed position.

2.8 DELUGE VALVES

.1 Provide c(UL)us Listed, FM Approved hydraulically operated, differential latching clapper-type valve.

.2 Valve construction: lightweight, ductile-iron construction with “screw in” stainless steel seat and clapper assembly.

.3 Provide O-ring seals to resist corrosion and leakage.

.4 Provide pressure actuated clapper facing, providing a limited compression seat for the sealing force between the clapper rubber facing and the valve seat.

.5 Provide external reset knob for resetting the clapper without having to remove the valve face plate.

.6 Stainless-steel piston/pushrod and spring assembly with diaphragm seal secured to the casting through a pushrod guide constructed of a synthetic engineering plastic to resist corrosion.

.7 Provide bleeder hole located on the pushrod chamber for air/water leakage indication. Trip ratio: approximately 3:1 force differential.

.8 Provide straight-through design to minimize friction loss activated by pneumatic actuation trim. Provide factory installed inlet restriction orifice into inlet port of deluge valve push-rod cover plate.

.9 Valve trim: galvanized and brass components cULus Listed, FM Approved with the deluge valve. Include 2” main drain, alarm line test, water pressure gauges, push rod chamber supply connections, manual emergency release valve, and closed drain assembly.

.10 Provide condensate drain to prevent water columning above the clapper. Size deluge valve with hydraulic calculations with grooved end connections per ANSI/AWWA C606. Rated working pressure of 250 psi (17.2 bar) and factory hydrostatic tested at 500 psi.

.11 Activated by electric actuation trim. Galvanized valve trim.

.12 Deluge valve releasing device: solenoid valve c/w brass body with stainless steel sleeve tube, springs, stop and plunger, and with ½" female NPT end connections. Maximum working pressure of 175 psi (12,1 bar) and maximum ambient temperature rating of 150ºF (66ºC).

.13 Power consumption of integrated coil limited to 10 watts and require 24 VDC from a releasing control panel listed for such service. Solenoid valve: ½" normally closed solenoid valve

2.9 COMPRESSED AIR SUPPLY

.1 Automatic Air Compressor.

.2 ULC listed.

.3 Capacity:

.1 To restore normal air pressure in system within 30 minutes.

.2 To provide air pressure of 140 kPa in excess of calculated trip pressure of dry pipe valve or in accordance with instruction sheet furnished with dry pipe valve.

.4 Piping: ferrous, NPS 3/4 screwed joints and fittings, to NFPA 13.

2.10 PRESSURE GAUGES

.1 ULC listed and to Section 23 05 19.13 - Thermometers and Pressure Gauges - Piping Systems.

.2 Maximum limit of not less than twice normal working pressure at point where installed.

2.11 RELIEF VALVE

.1 ULC listed.

2.12 SPARE PARTS CABINET

.1 For storage of maintenance materials, spare sprinkler heads and special tools.

.2 Construct to sprinkler head manufacturers standard.

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, inspect and test to acceptance in accordance with NFPA 13 and NFPA 25.

.2 Testing to be witnessed by authority having jurisdiction.

.3 Install water gong as indicated.

.4 Install fire department connections as indicated.

.5 Install spare parts cabinet as indicated.

.6 Pressure gauges:

.1 Location:

.1 On water side and air or nitrogen side of dry pipe valve.

.2 At air receiver.

.3 In each independent pipe from air supply to dry pipe valve.

.4 At exhausters and accelerators.

.2 Install to permit removal.

.3 Locate so as not subjected to freezing.

.7 Valve identification:

.1 Identify drain valve, by-pass valves and main shut-off valve and all auxiliary valves.

3.3 FIELD QUALITY CONTROL

.1 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 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

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

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Read and conform to:

.1 The Contract CCDC 2-2008, Stipulated Price Contract as amended,

.2 Division 1 requirements and documents referred to therein.

.2 This Section applies to and governs the work of all Sections of Division 22.

.3 The technical Sections of this Division are generally divided into units of work for the purpose of ready reference. The division of the work among subcontractors is not the Consultant's responsibility and the Consultant assumes no responsibility to act as an arbiter and/or to establish subcontract limits between any Sections of the work.

.4 The specifications are integral with the drawings which accompany them. Neither is to be used alone. Any item or subject omitted from one but implied in the other is fully and properly required.

.5 Wherever differences occur in the tender documents, the most onerous condition governs. Base the bid on the costliest arrangement.

1.2 DEFINITIONS

.1 The following are definitions of words found in this specification and on associated drawings under this Division:

.1	"Concealed"	locations hidden from normal sight in furred spaces, shafts, ceiling spaces, walls, and partitions.
.2	"Exposed"	mechanical work normally visible to building occupants.
.3	"Furnish"	(and its derivatives) has the same meaning as the term "Supply".
.4	"Install"	(and its derivatives) - receive, store and handle at the site, mount and support and connect all required services. Includes adjustment and calibration, testing, commissioning, inspection by authorities having jurisdiction and documentation.
.5	"Provide"	(and its derivatives) - supply, install in place, connect the associated required services ready for operation, adjust and calibrate, test, commission, warrant, and document. Includes inspection by authorities having jurisdiction.
.6	"Supply"	(and its derivatives) purchase and deliver to the site for installation. Includes submittals, manufacturer's field inspection and warranty.

.7 "Wet" locations exposed to moisture, requiring special materials and arrangement.

1.3 WORK INCLUDED

.1 Products and methods mentioned or shown in the Contract Documents complete with incidentals necessary for a complete operating installation. Provide all tools, equipment and services required to do the work.

.2 Cutting and patching of new or existing work.

.3 Identification of piping, and valves.

.4 Take such measures and include in Bid Price for the proper protection of the existing building and its finishes during alterations and construction of the new addition. Coordinate this protective work with all trades.

.5 Verify the correct operation of each plumbing fixture provided and/or altered and each system in total and obtain the Owner's approval prior to starting and/or returning to operation.

1.4 SUBMITTALS

.1 Shop Drawings: Prepare and submit two (2) copies of shop drawings of major equipment items (including those items specifically indicated under Part 1: General of each Section), to the Consultant for review. The Consultant will return one copy, marked with comments and his review stamp as he deems appropriate. Prepare the necessary number of copies of the returned set and distribute to the Owner, the Prime Consultant, the General Contractor, the site, and to subcontractors and suppliers.

.1 Clearly indicate manufacturer's and supplier's names, catalogue model numbers, details of construction, accurate dimensions, capacities and performance. Prior to submission check and certify as correct, shop drawings and data sheets. Do not order equipment until a copy of the shop drawings, reviewed by Consultant, has been returned to Contractor.

.2 Clearly indicate the weight, location, method of support and anchor point forces and locations for each piece of equipment on shop drawings.

.3 The Consultant will not review shop drawings that fail to bear the Contractor's stamp of approval or certification.

.4 Read the following in conjunction with the wording on the shop drawing review stamp applied to each and every drawing submitted:

"*This review by the Consultant is for the sole purpose of ascertaining conformance with general design concept. This review shall not mean that the Consultant approves the detail design inherent in the shop drawings, responsibility for which shall remain with the Contractor submitting same, and such review shall not relieve the Contractor of his responsibility for errors or omissions in the shop drawings or of his responsibility for meeting all requirements of the Contract Documents.*

The Contractor is responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for coordination of the work of all sub trades."

.2 Maintenance Data and Operating Instructions

.1 Submit three (3) copies of Operation and Maintenance Manual individually bound in hard backed three-ring binders.

.2 Ensure the binder spines have typewritten lettering as follows:

OPERATION & MAINTENANCE MANUAL

for

[Insert project name]

[Insert date of submission]

Division 22 00 00

.3 Provide a list of names, addresses and telephone numbers of equipment suppliers, installing contractors, general contractors, architect and Consultant. Include special telephone numbers for service departments on normal and emergency call basis.

.4 Provide descriptive literature (shop drawings) of each manufactured item. Include a bill of material with purchase order numbers and vendor's identification of equipment orders for each item.

.5 Include copies of start-up reports and checklists and all certificates issued with respect to this contract.

.6 Ensure operating instructions include the following:

.1 General description of each mechanical system.

.2 Step by step procedure to follow in putting each piece of equipment into service.

.3 Schematic control diagrams for each separate mechanical system.

.4 Diagram of the electrical control system indicating the wiring of all related electrical components.

.5 Drawings of each control panel including temperature control and electrical panels, completely identifying all components on the panels and their function.

.7 Ensure maintenance instructions include the following:

.1 Manufacturer's maintenance instructions for each item of mechanical equipment installed under this Division. Instructions shall include installation instructions, parts numbers and lists, name of supplier and maintenance and lubrication instructions.

.2 Summary list of each item of mechanical equipment requiring lubrication, indicating the name of the equipment item, location of all points of lubrication, type of lubricant recommended, and frequency of lubrication.

.3 Equipment directory indicating name, model, serial number and nameplate data of each item of equipment supplied, and system with which it is associated.

.4 Balancing and testing reports.

.5 Copy of valve directory.

.3 As-Built Records: Prepare and submit complete as-built records prior to Substantial Performance of the Contract. Refer to paragraph 3.3 and to Division 1 for requirements. Submit two sets of as-builts drawings in AutoCAD format showing changes & concealed services dimensioned. AutoCAD files can be provided to the contractor by the Consultant at a fee of $300.00 plus $25.00 per sheet upon request.

.4 Requests for Shut-Down: Obtain permission for systems shut-down and/or service interruption from the Owner prior to disruption of any system or service in use by the Owner. Employ the Owner's standard form of request where available. Refer to Division 1 for additional requirements.

.5 Requests for Start-up: Obtain permission from the Owner to start-up or to return to service any item of equipment, system or service installed new or previously shutdown. Refer to Division 1 for additional requirements.

1.5 QUALITY ASSURANCE

.1 Conform to minimum requirements or better of provincial and local codes, where existing, and to requirements of local inspection authorities for execution of work under this Division.

.2 Ensure materials supplied under this Division conform to minimum requirements and recommendations or better of applicable standards of the following:

.1 ASTM American Society of Testing and Materials

.2 AWWA American Water Works Association

.3 CAN2 National Standard of Canada (Published by CGSB)

.4 CAN3 National Standard of Canada (Published by CSA)

.5 CGSB Canadian General Standards Board

.6 CSA Canadian Standards Association

.7 NBC National Building Code of Canada

.8 OBC Ontario Building Code

.9 TIAC Thermal Insulation Association of Canada

.10 ULC Underwriter's Laboratories of Canada Ltd

.11 UL Underwriter's Laboratories (including cUL)

.3 Use latest editions and amendments in effect on date of Bid call subject to requirements of OBC.

.4 Arrange and pay for inspections by authorities having jurisdiction, required in the undertaking of this Division. Make modifications required by authorities.

.5 Ensure tradesmen employed on the project hold valid trade certificates/licenses and shall make a copy available for review by the Consultant and/or Owner when requested.

1.6 PRODUCT DELIVERY, HANDLING AND STORAGE

.1 Immediately after letting of contract, review material and equipment requirements for this work, determine supply and delivery dates for all items, and notify Consultant of any potential delays in completion of this project in order that remedial action may be taken.

.2 Store neatly out of the way and protected from damage and theft, materials and equipment supplied under this Division that are received at the site by this Division.

1.7 JOB CONDITIONS

.1 Visit site and examine existing conditions which may affect work of this Division.

.2 Examine Contract Documents to ensure that work of this Division may be satisfactorily completed.

.3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.

.4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without qualifications unless exceptions are specifically noted in the Bid.

1.8 INTERRUPTIONS

.1 Arrange execution of work to maintain present building operations, and to minimize the effect of work under this Division on existing operations.

.2 Prior to interrupting any existing service notify the Owner and Consultant, in writing, at least 7 days in advance, and obtain written authorization. Do not interrupt any existing service without Consultant's specific authorization. Refer to Division 1 for requirements.

.3 Include in Bid Price for all overtime or premium time hours necessary to minimize duration of service interruption.

.4 Test and verify the proper operation of existing equipment and systems that are shut down due to work of this project, prior to returning to service.

.5 Assume responsibility for consequential costs on failure to obtain permission to

shut down and/or start-up any item of equipment, system or service.

1.9 WARRANTY

.1 Refer to Division 01.

1.10 EXTRAS AND CREDITS

.1 Accompany price submissions requested by Consultant for extra work, or work to be deleted, with a complete cost breakdown as follows:

.1 Materials, quantities, and unit costs including any applicable contractors trade discount clearly identified. Provide supplier quotations.

.2 Labour hours and unit costs.

.3 Total materials and labour costs.

.4 Overhead and profit mark-ups in accordance with the General Conditions of the Contract.

.2 Quotations from software such as Allpriser will not be accepted. Provide actual material costs.

2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

.1 Ensure materials and equipment provided under this Division are new and free from defects and bear labels of approval as required by codes referred to in this Division and/or by inspection authorities.

.2 Ensure apparatus and equipment provided under this Division bears manufacturer's nameplate indicating name of manufacturer, model number or type, size, capacity, CRN, and other pertinent information. Ensure nameplates are easily read and clearly visible, with openings provided where equipment is insulated.

.3 Ensure manufacturers and suppliers of equipment or materials under this Division determine if their products are composed of any hazardous materials. If they are, the products are suitably labeled and supplied with Material Safety Data sheets. Obtain the Owner's approval in writing to bring hazardous materials onto the site prior to doing so.

.4 When utilizing any products that are hazardous, keep Material Safety Data sheets on file at the job site and present them to anyone requesting this information. When transferring hazardous materials from original container into other containers, provide Workplace Labels on such containers.

2.2 ACCEPTABLE PRODUCTS

.1 First item named or specified by catalogue number meets specifications

regarding performance, quality of material and workmanship, and is acceptable to the Consultant.

.2 Items, other than first named, meeting specifications regarding quality of materials and workmanship are acceptable to the Consultant, only if they also meet performance and/or capacities specified and can be accommodated within the space allotted.

.3 General approval indicated by inclusion of other manufacturers named is subject to final review of shop drawings, performance data and test reports.

2.3 EQUIVALENTS AND ALTERNATIVES

.1 Suppliers wishing approval for additional equipment items or alternatives as equivalent to those specified **must submit complete description, technical and performance data to Consultant at least twelve (12) working days prior to Bid closing date.** Equivalent equipment, if accepted, must conform to specifications regarding details, accessories, modifications, features and performance. Deviations from specifications must be stated in writing at time of submission for approval.

.2 Bid Prices shall include only products specified or approved equivalents.

2.4 SUBSTITUTIONS DURING PROGRESS OF WORK

.1 Refer to Section 01 25 00.

2.5 CONSULTANT'S REVIEW

.1 The consultants will review and evaluate unsolicited alternatives and substitutions proposed by the Contractor. Such review and evaluation work will be undertaken by the Consultant on an additional fee basis. The Contractor shall reimburse the Owner for all costs associated with such reviews and evaluations.

.2 The Contractor shall also reimburse the Owner for costs incurred in updating Contract Documents to reflect such changes.

3 EXECUTION

3.1 RELATIONSHIP WITH OTHER TRADES

.1 Cooperate with other trades whose work affects or is affected by work of this Division to ensure satisfactory installation and to avoid delays.

.2 Provide materials to be built-in, such as sleeves, anchors, and inserts, together with templates and/or measurements, promptly when required by other trades.

.3 Provide structural supports for equipment to be mounted on or in walls, supported above floors and/or suspended from the structure.

3.2 INSTALLATION REQUIREMENTS

.1 The Consultant's drawings and instructions govern the location of all items. Prepare fully coordinated installation drawings prior to installation.

.2 Install equipment neatly to the satisfaction of the Consultant. Unless noted, install products and services to follow building planes. Ensure installation permits free use of space and maximum headroom.

.3 Confirm the exact location of outlets, fixtures and connections. Confirm location of outlets for equipment supplied under other Divisions.

.4 Install equipment and apparatus to allow free access for maintenance, adjustment and eventual replacement.

.5 Provide suitable shielding and physical protection for devices.

.6 Install products and services in accordance with the manufacturer's requirements and/or recommendations.

.7 Provide bases, supports, hangers and fasteners. Secure products and services so as not to impose undue stress on the structure and systems.

.8 Do not use power activated tools without written permission of the Consultant. Use them in accordance with the Owner's health and safety policies.

3.3 CONTRACT DRAWINGS

.1 The drawings of this Division are performance drawings and indicate general arrangement of the work. They are diagrammatic except where specific details are given.

.2 Obtain accurate dimensions from the architectural and structural drawings, or by measurement. Location and elevation of services are approximate. Verify them before construction is undertaken.

.3 Make changes where required to accommodate structural conditions (beams, columns, etc.). Obtain Consultant's approval before proceeding.

.4 Adjust the location of materials and/or equipment as directed without adjustment to contract price, provided that the changes are requested before installation and do not affect material quantity. **Note that outlets and/or equipment may be relocated up to 10 feet (3 m) in any direction without a change to the contract price**.

.5 The drawings of this Division are intended for tender pricing. The quantities and quality to be included in the bid price shall be based on the layout and specifications as shown on the mechanical documents. If there is a difference in quantity between the architectural and drawings of this Division, base the contract price on the greater quantity.

3.4 RECORD DRAWINGS

.1 Maintain project "as-built" record drawings. Obtain white prints from the Consultant for this purpose and pay printing costs. Identify each set as "Project Record Copy".

.2 Record deviations from contract documents caused by site conditions or by changes ordered by the Consultant. Record deviations in red ink clearly and accurately, using industry standard drafting procedures consistent with quality and standards of Consultants documents.

.3 Record deviations as work progresses throughout the execution of this contract. Maintain record drawings on site in clean, dry, legible condition, making them available for periodic review by the Consultant.

.4 Record location of concealed services, particularly underground services. Before commencing any backfilling, obtain accurate measurements and information concerning correct location and depth of services.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 22 01 01 – General Requirements.

1.2 WORK INCLUDED

.1 Identification of existing services and utility connections.

.2 Installation, protection and maintenance of temporary services as required to support continuing operation of the facility.

.3 Disconnection and removal of various mechanical equipment in areas to be turned over to the Owner.

.4 Disconnection and making safe of various mechanical systems and equipment in areas to be demolished and/or renovated.

.5 Disposal of waste materials in accordance with waste management requirements.

1.3 REGULATORY REQUIREMENTS

.1 Notify authorities of intent to demolish and schedule for the work. Obtain required permits from authorities.

.2 Conform to codes for demolition work, dust control, products requiring disconnection and re-connection.

.3 Do not close or obstruct egress width to any building or site exit.

.4 Do not disable or disrupt building fire or life safety systems without 3 days prior written notice to Owner.

.5 Conform to procedures applicable when hazardous or contaminated materials are discovered. Refer to designated hazard substance report for such procedures.

1.4 JOB CONDITIONS

.1 Visit site and examine existing conditions which may affect work of this Division.

.2 Examine Contract Documents to ensure that work of this Division may be satisfactorily completed.

.3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.

.4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without qualifications, unless exceptions are specifically noted in the Bid.

1.5 INTERRUPTIONS

.1 Arrange execution of work to maintain present building operations, and to minimize the effect of work under this Division on existing operations.

.2 Prior to interrupting any existing service notify the Owner and Consultant, in writing, at least 7 days in advance, and obtain written authorization. Do not interrupt any existing service without Consultant's specific authorization. Refer to Division 01 for requirements.

.3 Arrange time and duration of interruption through the Owner's Physical Plant Department. Include in Bid Price for all overtime or premium time hours necessary to minimize duration of service interruption.

.4 Test and verify the proper operation of existing equipment and systems that are shut down due to work of this project, prior to returning to service.

.5 Assume responsibility for consequential costs on failure to obtain permission to shut down and/or start-up any item of equipment, system or service.

1.6 PHASING AND SCHEDULING

.1 Refer to Division 01 phasing and scheduling of the work.

.2 Coordinate with the work of Division 22 with other trades and assist in the development of the Phasing Strategy.

2 PRODUCTS

2.1 PRODUCTS

.1 (N/A)

3 EXECUTION

3.1 PREPARATION

.1 Prior to start of work under this Section, ensure that the General Trades:

.1 Provide, erect, and maintain temporary barriers at locations indicated.

.2 Erect and maintain weatherproof closures for exterior openings.

.3 Erect and maintain temporary partitions to prevent spread of dust, odours, and noise to permit continued Owner occupancy.

.4 Prevent movement of structure; provide bracing and shoring.

.2 Install, protect and maintain temporary services as required to support continuing operation of the facility.

.3 Protect services and equipment which are not to be demolished.

.4 Coordinate all service shutdowns with Owner's project coordinator. Provide notice as required by Owner and submit schedule for the work.

.5 Notify affected utility companies before starting work and comply with their requirements.

.6 Mark location and termination of utilities.

.7 Provide appropriate temporary signage including signage for exit or building egress.

3.2 RELATIONSHIP WITH OTHER TRADES

.1 Cooperate with other trades whose work affects or is affected by work of this Division to ensure satisfactory installation and to avoid delays.

.2 Remove and dispose of built-in items such as sleeves, anchors, and inserts.

.3 Remove and dispose of bases, supports and anchors for piping mounted on or in walls, supported and suspended from the structure.

3.3 PROTECTION

.1 Protect existing and new work to remain free from damage due to execution of work under this Division with tarpaulins and other protective coverings as necessary.

.2 Repair damage to the building and components resulting from failure to provide sufficient protection, to the satisfaction of the Consultant.

.3 In the event that dust and debris from construction work does penetrate the building and/or its air distribution systems, be responsible for cleaning the affected areas and/or systems.

3.4 DEMOLITION

.1 Notify authorities of intent to demolish and schedule for the work.

.2 Conform to codes, regulations, standards and by-laws applicable to the work.

.3 Isolate and drain systems as required to effect demolition. Disconnect, cap and make safe all mechanical services to the building including, but not limited to; sanitary sewer(s), storm sewer(s), water service, and natural gas service.

.4 Protect existing equipment and services to remain from debris and unwanted materials. Clean as necessary to maintain service during demolition period and on completion of the work.

.5 Coordinate service shutdowns with Owner's project coordinator. Provide notice as required by Owner and submit schedule for the work.

.6 Remove and dispose of all redundant mechanical services and equipment within the limits of the demolition site and where demolished systems extend beyond these limits.

.7 Turn over items identified for recovery by the Owner.

.8 Conform to Occupational Health & Safety and Environmental regulations. Ensure that all parties are familiar with requirements and experienced in the work to be undertaken.

.9 Conform to the requirements of Division 01, municipal By-Laws and Ministry of the Environment regulations and standard for waste disposal.

.10 In the event that dust and debris from demolition work does penetrate the building and/or its air distribution systems, be responsible for cleaning the affected areas and/or systems.

.11 Disconnect remove, cap and identify utilities within demolition areas.

.12 Demolish in an orderly and careful manner. Protect existing supporting structural members.

.13 Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.

.14 Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.

.15 Remove temporary Work.

3.5 RENOVATIONS

.1 Isolate and drain systems as required to effect renovations, modifications and/or repairs. On completion of renovations, modifications and/or repairs, test entire system as if new. Report repairs or replacements required of existing equipment, piping, fittings or devices that are not included in contract to Consultant and Owner for instruction. Flush, clean and refill renovated systems as specified for new.

.2 Relocate or remove existing items so designated unless specifically indicated to be relocated or removed under other Sections.

.3 Cleaned and Repair or alter existing items to be relocated to suit new location. Replace damaged or ineffective parts and make the item "as new".

.4 Delivery existing items to be removed remain the property of the owner to a location on site designated by the owner. If the owner declares no interest in the removed items, assume ownership and remove the items from the site.

.5 Make good surfaces and finishes in areas from which items have been removed and in which items are relocated. Cap existing services required to be severed to effect alterations and do all other work necessary to make good such areas to satisfaction of consultant.

.6 Temporarily seal openings in existing floor assemblies and vertical fire separations necessitated by installation of equipment and systems or construction in general with fire barrier materials such as mineral wool or other noncombustible insulation.

.7 If during alteration work existing asbestos material, other than known asbestos, is discovered (e.g. fireproofing, acoustic or thermal insulation, tank covering), stop

work in the affected area and immediately notify consultant.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 22 01 01.

1.2 SECTION INCLUDES

.1 Piping specialties

.2 Adhesives, sealants, paints, and coatings.

.3 Firestopping compounds.

.4 Tags.

.5 Access doors.

.6 Escutcheons.

.7 Penetration Seals.

1.3 REFERENCE STANDARDS

.1 Provide all work in accordance with requirements of Regulatory Agencies and conform to:

.1 Local and district by-laws, regulations and published engineering standards.

.2 the Ontario Building Code as amended,

.3 Regulations for Construction Projects under The Occupational Health and Safety Act.

.2 ASTM International (ASTM)

.1 ASTM A105 - Standard Specification for Carbon Steel Forgings for Piping Applications.

.2 ASTM A182 - Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.

.3 American Society of Mechanical Engineers (ASME)

.1 ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24, Metric/Inch Standard.

.4 CSA Group (CSA):

.1 CSA B242 Groove and Shoulder Type: Mechanical Pipe Couplings.

.2 CAN1-B149.1 Natural Gas and Propane Code.

.5 Standards Council of Canada (SCC)

.1 CAN/ULC – S115, Standard Method Of Fire Tests Of Firestop Systems

.6 Conform to following National Research Council Canada publications:

.1 National Building Code of Canada and Supplements to National Building Code of Canada

.2 Canadian Plumbing Code.

1.4 QUALIFICATIONS

.1 Firestop Sealant Manufacturer: Company specializing in manufacture of sealants with minimum three years' documented product development, testing, and manufacturing experience.

.2 Firestop components and assemblies shall be ULC listed and tested in accordance with ULC S115 Standard Method of Fire Test for Firestop Systems.

1.5 SUBMITTALS

.1 Submit shop drawings in accordance with Section 22 01 01.

1.6 DELIVERY, STORAGE, AND HANDLING

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

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

1.7 WASTE MANAGEMENT & DISPOSAL

.1 Separate and recycle waste materials in accordance with Division 01 Waste Management and Disposal, and with the Contractor's Waste Reduction Workplan.

.2 Place materials defined as hazardous or toxic waste in designated containers.

.3 Ensure emptied containers are sealed and stored safely for disposal away from children.

2 PRODUCTS

2.1 PIPING SPECIALTIES

.1 Provide cast brass, pressure, copper to copper unions for seamless copper tubing smaller than 3" (75 mm).

.2 Provide cast brass flanges with seamless copper tubing, type L for tubing 3" (75 mm) and larger.

.3 Provide dart type, 125 lb. (860 kPa) black malleable iron unions for steel pipe for piping 2-1/2" (65 mm) and smaller.

.4 Provide RFSO CL150 steel flanges for steel pipe for piping larger than 2-1/2" (65 mm).

.5 Provide Cranite ring type gaskets.

.6 Provide line sized piping specialties unless indicated otherwise on drawings.

2.2 STRAINERS

.1 Manufacturers:

.1 S. A. Armstrong

.2 Conbraco

.2 In copper tubing: Class 250, wye type, bronze, screwed connection, with blind caps, and 1/32" (0.8 mm) perforated stainless steel screen.

2.3 ADHESIVES, SEALANTS, PAINTS AND COATINGS

.1 Adhesives, Sealants, Paints and Coatings: Use only low VOC emitting materials meeting following criteria:

.1 Paint for Mechanical Identification: maximum VOC emission of 250g/L

.2 Touch-Up Paint: maximum VOC emission of 250g/L

.3 Zinc-Rich Primer: maximum VOC emission of 250g/L

.4 Adhesives for Mechanical Identification: maximum VOC emission of 70g/L

.5 Sealants for service penetrations: maximum VOC emission of 650g/L clear and 350 g/L pigmented

.6 Sealants for Firestopping: max. VOC emission of 650g/L clear and 350 g/L pigmented

.7 Acrylic Sealant for supports and anchors: maximum VOC emission of 250g/L

.8 Insulation Vapour Barrier Lap Adhesive: maximum VOC emission of 80g/L

.9 Insulation Joint Sealer: maximum VOC emission of 250g/L

.10 Insulation Vapour Barrier Mastic: maximum VOC emission of 400g/L

.11 Flame Retardant Adhesive: maximum VOC emission of 650g/L clear and 350 g/L pigmented

2.4 FIRESTOPPING COMPOUNDS

.1 Manufacturer: 3M products indicated.

.2 Other acceptable manufacturers offering equivalent products.

.1 Dow Corning

.2 John Manville

.3 Hilti Firestop Systems

.3 Fire Rated Sealants: intumescent material, synthetic elastomers, capable of expanding up to 8 to 10 times when exposed to temperatures of 250°F (121°C) or higher. ULC listed and labelled.

2.5 TAGS

.1 Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background colour. Tag size minimum 1-1/2" (40 mm) diameter. OR

.2 Metal Tags: Brass, aluminum or stainless steel with stamped letters; tag size minimum 1-1/2" (40 mm) diameter with smooth edges.

.3 Chart: Typewritten letter size list in anodized aluminum frame.

2.6 ACCESS DOORS

.1 Standard:

.1 Minimum 12ga

.2 steel, prime coat painted

.3 heavy duty fully concealed hinges

.4 screwdriver operated, cam latch

.2 Concealed (Recessed):

.1 Minimum 12ga.

.2 steel, prime coat painted

.3 heavy duty fully concealed hinges

.4 screwdriver operated, cam latch

.3 Fire Rated:

.1 Access doors in fire separations or fire rated assemblies: ULC labelled.

.2 Refer to architectural drawings for ratings of fire separations and assemblies.

.3 Minimum 12ga

.4 steel, prime coat painted

.5 heavy duty fully concealed frame and hinges

.6 screwdriver operated, cam latch

2.7 ESCUTCHEONS

.1 Finish: Polished chrome

2.8 PENETRATION SEALS

.1 Manufacturer: Link-Seal

.2 Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut.

3 EXECUTION

3.1 INSPECTION

.1 Inspect installed work of other trades and verify that such work is complete to point where work under this Division may properly commence.

.2 Verify that work of this Division may be executed in accordance with pertinent codes and regulations, specifications, drawings, and referenced standards.

.3 Review drawings and verify dimensions at the site. Report discrepancies immediately to Consultant before proceeding with any construction work or shop drawings.

3.2 PREPARATION

.1 Relocate or remove existing services and equipment to suit new construction and renovation work.

.2 Remove or cut back and cap services that are no longer required to the satisfaction of Consultant.

.3 Obtain written authorization from Consultant for renovation work that is not specifically indicated.

.4 Where modifications or connections to existing systems require shutdown of the system, shall submit a request for system shutdown describing the system or part to be shutdown, the duration of the shutdown, the work planned and steps to be taken to reinstate the system to full operation. Submit request in the format stipulated by the Owner.

.5 Include work required to prepare systems for shutdown and/or re-instatement, such as draining, chemical treatments, and re-filling in this Bid Price.

3.3 PIPING INSTALLATION - ABOVE GROUND

.1 Cooperate with other trades whose work affects or is affected by work of this Section, to ensure satisfactory installation and to avoid delays. Provide materials to be built-in such as sleeves, anchors, etc., together with accurate dimensions or templates, promptly.

.2 Layout work accurately, installing piping parallel to lines of building.

.3 Install piping, wherever possible, in partitions and above ceiling. Do not install piping in outside walls unless so shown on drawings. Wrap un-insulated piping in masonry walls with building paper.

.4 Install concealed piping close to building structure to minimize furring dimensions.

.5 Provide adequate space around piping to facilitate application of insulation.

.6 Use dielectric couplings where piping of dissimilar metals connect.

.7 Where piping passes through concrete floors, or walls, size sleeves to permit the pipe to expand freely without binding or crushing pipe insulation.

.8 Where branch pipes are welded into main without the use of "T" connections, cut torch cut openings true, bevel and file smooth. Ensure branch pipes do not project inside of main pipe. Do not cut openings large enough to permit entry of welding metal and slag within the pipe.+

.9 Arrange take-offs from mains to allow for expansion and contraction of pipes.

.10 When using PVC-DWV pipe, provide for expansion and contraction of risers by using ProSet E-Z Flex Coupling in accordance with good engineering practices.

3.4 PIPING JOINTS

.1 Make joints in piping installed under this Division using persons familiar with the particular materials being used and in accordance with Canadian Plumbing Code, manufacturer's instructions, and as specified herein.

.2 Use 95/5 Sb.Sn (tin-antimony) solder for joining copper drainage tubing smaller than 4" (100 mm), and for joining copper water tubing installed above grade, and smaller than 4" (100 mm).

.3 Use silver solder or Silfos for joining copper water tubing installed below grade, and all copper tubing 4 " (100 mm) and larger in size.

.4 Carefully ream joints in threaded pipe and paint with approved graphite type joint sealer on male connections only. Make connections with proper wrench to suit pipe size. Where leaks occur, the joint shall be disassembled and corrected if possible, or replaced. Over-tightening, caulking or peening will not be acceptable.

.5 Make joints in cast iron pipe with standard M-J joints in accordance with manufacturer's recommendations and CSA B70.

.6 When using Victaulic Grooved Piping Method:

.1 Make joints in grooved piping with couplings and gaskets in accordance with Victaulic Company of Canada Ltd, General Catalogue G-100, latest edition. Cut or roll grooves using tools specifically designed for that purpose.

.2 Use Zero-flex or rigidlok couplings in locations where rigidity is required,

in particular in mechanical rooms on coils, headers and pumps.

.3 Vic-Boltless couplings may be used.

.7 Install unions or welding flanges at connections to valves, etc. to facilitate removal.

.8 Use butt welding and/or schedule 40 carbon steel welding fittings to join sections of steel piping with welding ends.

3.5 FLUSHING AND CLEANING

.1 Flush and sterilize domestic water mains in accordance with procedures established by AWWA Specification C601.

.2 Flush new domestic water piping in accordance with Local and Provincial Codes.

.3 Thoroughly flush all other piping installed by this Division.

.4 Remove, clean and replace all strainers in systems after flushing.

.5 Thoroughly clean all equipment and fixtures, lubricate mechanical equipment, and leave all items in perfect order ready for operation.

3.6 EQUIPMENT TESTING AND INSPECTION

.1 Test operation of equipment installed under this Division according to instructions in appropriate articles of this Division. Make any required adjustments or replacements to ensure equipment is operating as intended. Retest equipment requiring adjustment or replacement.

.2 Pay all fuel consumption charges for equipment under testing and during commissioning.

.3 Conduct tests before application of external insulation and before concealment of piping or ductwork.

.4 Arrange and pay for inspections by authorities as required by code and complete any changes or alterations required by such inspections.

.5 Conduct tests in the presence of:

.1 Authorized inspector(s) for authorities having jurisdiction.

.2 The Owner's Representative.

.6 Notification must be given at least 48 hours in advance of tests being conducted, to all persons required to be present.

3.7 PIPING SYSTEMS TESTING AND INSPECTION

.1 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures.

.2 Test all piping at the completion of roughing-in, before connecting to existing systems, and prior to concealment, insulation or covering of piping.

.3 Make tests, that are required by any authority having jurisdiction, in the presence of the authority's authorized inspector and shall be certified by him.

.4 Conduct tests in the presence of:

.1 Authorized inspector(s) for authorities having jurisdiction.

.2 The Owner's Representative

.5 Notification must be given at least 48 hours in advance of tests being conducted, to all persons required to be present.

.6 Repair all leaks exposed during testing and retest. If defects in pipe or fittings are discovered in the system, they shall be removed and replaced.

.7 Certify tests not required by authorities having jurisdiction.

3.8 TESTING AND BALANCING

.1 Allow sufficient time for testing and verification prior to substantial completion. Notify Testing and Balancing Agency on completion of adjusting and balancing of systems.

.2 Maintain systems in full operation during testing and verification.

3.9 PROTECTION

.1 Protect finished and unfinished work by tarpaulins, or other covering, from damage due to execution of work under this Division.

.2 Repair to satisfaction of Consultant, damage to building resulting from failure to provide such protection.

3.10 EXCAVATING AND BACKFILLING

.1 Be responsible for excavation and backfilling necessary for installation of underground work under this Division.

.2 Excavate with suitable machinery or by hand as may be necessary and as follows:

.1 Excavate to the depth and dimensions shown on drawings.

.2 Keep excavation free of water by bailing, pumping or a system of drainage as required.

.3 Cut and trim banks of excavation evenly, as nearly vertical as possible, and shore if required to prevent caving-in.

.4 Keep bottom of excavation clean and clear of loose material. Slope or grade as required.

.5 Provide shoring in accordance with The Occupational Health and Safety Act and Regulations for Construction Projects.

.6 Notify Consultant immediately in case of encountering any unstable ground, unsuitable for bearing of pipes. Consultant will decide the

method of installation of pipes in unstable ground.

.7 Inform Consultant immediately if the excavation reveals seepage zones, springs or other unexpected sub-surface conditions which may necessitate revisions to drainage or water supply systems.

.3 Obtain Consultant's approval prior to commencement of backfilling of trenches. Backfill the trenches carefully to prevent injury to the work and subsequent settlement and execute backfilling generally as follows:

.1 Provide minimum 6" (150 mm) fine gravel or coarse sand bedding (Class B) or as indicated for the bottom of trenches.

.2 Backfill above pipe bedding with granular material specified, hand tamp in layers of 6" (150 mm) thickness. Extend backfill 12" (300 mm) above pipe.

.3 Backfill and consolidate remainder of trench depth below paved or graveled areas with granular Class "B" aggregate in 6" (150 mm) layers to an elevation to allow for thickness of Class "A" aggregate and asphalt pavement.

.4 Backfill and consolidate reminder of trench depth below sodded or seeded areas with specified granular material or material obtained from site excavation where approved by Consultant, in 9" (225 mm) layers to an elevation 6" (150 mm) below of proposed grades in sodded/seeded areas.

.5 Compact each layer thoroughly at optimum moisture content with approved hand or mechanical tampers to a density equal to;

.1 95% of Maximum Standard Proctor Density

.1 Behind foundation and retaining walls on grades

.2 Below sodded or seeded areas

.2 100% of Maximum Standard Proctor Density

.1 Below slabs on grade within building areas up to the underside of the crushed stone underlay

.2 Below paved or graveled areas

.6 Do not puddle or flood with water for consolidating backfill. Add Water during the compaction to optimum moisture content of backfilling material.

3.11 SEALANTS & CAULKING

.1 Fill voids around pipes:

.1 Seal between sleeve and pipe in foundation walls and below grade floors with penetration seals (link-seal)). Install as per manufacturer's installation instructions.

.2 Where sleeves pass through non-fire rated walls or floors, caulk space

between pipe and sleeve with fibreglass. Seal space at each end with waterproof, fire retardant, non-hardening mastic.

.3 Ensure no contact between copper tube or pipe and ferrous sleeve.

.4 Fill future-use sleeves with easily removable filler.

.5 Coat exposed exterior surfaces or ferrous sleeves with heavy application of zinc rich paint (VOC content not to exceed 250 g/L).

.2 Temporarily plug all openings during construction.

3.12 FIRESTOPPING

.1 Protect openings in fire separations and fire rated assemblies for service penetrations with ULC listed service penetration firestop systems (SP).

.2 Ensure service penetration firestop system have F and FT ratings equal to or greater than ratings specified by the Architect for the fire separation (F) and firewall (FT) joint firestop systems (JF).

.3 Ensure components employed in the service penetration firestop system shall conform to the ULC listing.

.4 Prepare and submit a schedule of service penetration firestop systems to be employed indicating the ULC listing designation, services involved, location of opening through fire separation and the components of the fire separation assembly.

.5 Refer to architectural drawings for ratings of fire separations and assemblies.

3.13 FLASHINGS

.1 Provide flashing at each point where piping passes through the roof.

.2 Coordinate this work with the roofing Trades to ensure a satisfactory installation and to avoid delays.

3.14 ESCUTCHEONS AND PLATES

.1 Provide escutcheons on pipes passing through finished walls, partitions, floors and ceilings.

.2 Use chrome or nickel plated brass, solid type with set screws for ceiling or wall mounting.

.3 Ensure inside diameter fits around finished pip and outside diameter covers opening or sleeve.

.4 Where sleeve extends above finished floor, ensure escutcheon or plates clear sleeve extension.

.5 Secure to pipe or finished surface, but not insulation.

3.15 PAINTING

.1 Repair minor damage to finish of equipment with standard factory applied baked enamel finish under the appropriate Sections of this division. Replace entirely, items suffering major damage to finish if too extensive to be repaired in the opinion of the Consultant.

.2 Apply at least one coat of corrosion resistant primer paint to supports, and equipment fabricated from ferrous metals.

3.16 SUPPORT AND ATTACHEMENT

.1 Support and attach piping from load bearing structures such as beams, joists, reinforced concrete slabs and concrete block walls, and do not support from or attach to steel roof deck and/or wall or ceiling finishes.

3.17 DISSIMILAR METALS

.1 Separate dissimilar metals to prevent galvanic corrosion.

.2 Provide gaskets or shims of approved materials to avoid electrolytic action.

.3 Use dielectric unions and/or flanges where piping of dissimilar metals are connected.

3.18 SERVICE CONNECTIONS

.1 Include in Bid Price amounts required by municipality and/or utilities for service connections and /or modifications to service connections for water services. Ensure amounts include fees, assessments, charges, etc., required in relation to service connection. Do not include acreage or frontage charges.

3.19 ADJUST AND CLEAN

.1 Clean equipment and fixtures, lubricate mechanical equipment installed under this Division and leave items in perfect order ready for operation.

.2 Test and adjust control devices, instrumentation, relief valves, dampers, etc., installed in this Division after cleaning of systems and leave in perfect order ready for operation.

.3 Remove from the premises upon completion of work of this division, debris, surplus, and waste materials resulting from operations.

3.20 MECHANICAL IDENTIFICATION INSTALLATION

.1 Degrease and clean surfaces to receive adhesive for identification materials.

.2 Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer (VOC content not to exceed 680 g/L).

.3 Install tags with corrosion resistant chain.

.4 Comply with standard detail drawing plate, "Detail of Piping Identification".

.5 Install plastic tape pipe markers complete around bare pipe to manufacturer's instructions.

.6 Identify valves in main and branch piping with tags. Consecutively number valves in each system.

.7 Identify piping, concealed or exposed, with stenciled painting and plastic tape pipe markers. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 6 m on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

3.21 MECHANICAL IDENTIFICATION SCHEDULES

.1 Consult the Owner and identify piping, ductwork and equipment as directed;

.1 conforming to the Owner's existing identification practices, or

.2 conforming to the following Pipe and Valve Identification Table:

Pipe Marker Legend	Valve Tag Legend	Primary Colour	Secondary Colour
Cold Water	CW	Green	None
Dom. Hot Water Supply	DHWS	Green	None
Dom. Hot Water Recirc.	DHWR	Green	None
Sanitary Sewer	-	Green	None
Storm Sewer	-	Green	None
Vent	-	Green	None

.2 Where coloured PVC jacketing is specified, conform to the following schedule;

Service	Legend	Colour
Cold Water	CW	Dark Green
Dom. Hot Water Supply	DHWS	Yellow

Dom. Hot Water Recirc.	DHWR	Yellow
Sanitary Sewer	SAN	Dark Grey
Storm Sewer	STRM	Light Grey

3.22 INSTALLATION OF ACCESS DOORS

.1 Supply access doors for access to equipment requiring service, lubrication or adjustment and all concealed valves, cleanouts, and other such equipment.

.2 Turn over access doors to the appropriate general trade for installation under other Sections.

.3 Refer to architectural drawings for ratings of fire separations and assemblies. install fire rated access doors in fire rated partitions, walls, and ceilings.

.4 Access doors in ceilings: minimum 24" x 24" (600mm x 600mm), unless otherwise approved by the Consultant.

.5 Provide concealed access doors in GWB ceilings and coordinate in-fill with general trades.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 22 01 01.

1.2 SECTION INCLUDES

.1 Flexible pipe connectors.

.2 Expansion joints and compensators.

.3 Pipe loops, offsets, and swing joints.

.4 Anchors and guides

1.3 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24, Metric/Inch Standard.

.2 ASME B31.1 - Power Piping.

.3 ASME B31.9 – HVAC Piping.

.4 ASME BPVC – Boiler and Pressure Vessel Code.

.2 ASTM International (ASTM)

.1 ASTM A105, Standard Specification for Carbon Steel Forgings for Piping Applications

.2 ASTM A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

.3 ASTM B169, Standard Specification for Aluminum Bronze Sheet, Strip, and Rolled Bar.

.4 ASTM A193, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.

.5 ASTM A194, Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.

.6 ASTM A240, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

.7 ASTM A516, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service.

.8 ASTM B650, Standard Specification for Electrodeposited Engineering

Chromium Coatings on Ferrous Substrates.

.9 ASTM F1007, Standard Specification for Pipeline Expansion Joints of the Packed Slip Type for Marine Application.

.3 Canadian Standards Association (CSA)

.1 CSA B51, Boiler, Pressure Vessel and Pressure Piping Code.

.4 Expansion Joint Manufacturers Association (EJMA)

.1 Standards of the Expansion Joint Manufacturers Association.

.5 Military Specifications (MIL)

.1 MIL-E-17814E - Expansion Joints, Pipe, Slip-Type, Packed.

1.4 PERFORMANCE REQUIREMENTS

.1 Provide structural work (i.e. anchor points) and equipment required to control expansion and contraction of piping.

.2 Verify that anchors, guides, and expansion joints provided, adequately protect system.

.3 Arrange piping so that expansion and contraction of any piping may take place without placing undue strain on the piping or connections to the equipment. Use swing joints and suitable expansion joints wherever necessary due to field conditions and where indicated on the drawings.

.4 Analyze each section of pipe installed between constraints and determine the potential for expansion of the pipe based on pipe temperature at installation and pipe temperatures throughout the pipe's operating range. Pipe sections are constrained where they penetrate walls, partitions, floors, ceilings, roofs and movement of the pipe is restricted and where the pipe is anchored to the building structure.

.5 Where potential expansion exceeds 1" (25 mm) over the length of the pipe section, provide means of expansion compensation.

.6 Notify the Consultant in writing when additional anchoring points are recommended to divide the piping system into manageable sections for the purpose of providing a complete pipe expansion compensation installation.

.7 Expansion Calculation Temperatures

.1 Use maximum operating temperatures of actual systems for calculation of piping expansion and contraction.

.2 Use an installation temperature of 10°C for hot piping and 20°C for cold piping.

1.5 SHOP DRAWING SUBMITTALS

.1 Refer to Sections 01 33 00 & 22 01 01

.2 Product Data:

.1 Flexible Pipe Connectors:

- .1 Maximum temperature and pressure rating,
- .2 Face-to-face length
- .3 Live length
- .4 Materials of construction
- .5 Hose wall thickness, hose convolutions per metre and per assembly,
- .6 Fundamental frequency of assembly,
- .7 Braid structure, and total number of wires in braid.
- .8 Maximum allowable deflections
- .9 End fittings
- .10 Pressure test information (test pressure and duration)
- .11 MTR's
- .12 Other NDE (dye penetrant, X-ray, etc.) methods and results.
- .13 CRN.

.2 Bellows Type Expansion Joints:

- .1 Maximum temperature and pressure rating.
- .2 Materials of construction.
- .3 Type of expansion joint.
- .4 Maximum axial, lateral and angular movements.
- .5 Fatigue life cycles (EJMA or ASME B31.3).
- .6 Face to face dimensions.
- .7 End fitting connections.
- .8 Liner ID.
- .9 Axial, lateral and angular spring rates.
- .10 Effective area.
- .11 Maximum thrust force at operating pressure.
- .12 Pressure test information (pressure and duration).
- .13 Other NDE methods and results (dye penetrant, x-ray, etc).
- .14 MTR's.
- .15 Accessories.
- .16 CRN.

.3 Slip-type Expansion Joints

.1 Maximum temperature and pressure rating.

.2 Materials of construction.

.3 Maximum axial movements.

.4 Face to face dimensions.

.5 End fitting connections.

.6 Liner ID.

.7 Axial spring rate.

.8 Effective area.

.9 Maximum thrust force at operating pressure.

.10 Pressure test information (pressure and duration).

.11 Other NDE methods and results (dye penetrant, x-ray, etc).

.12 MTR's.

.13 Accessories.

.14 CRN.

.3 Design Data: Submit detailed construction drawings for expansion compensation and piping anchors, signed and sealed by a professional engineer licenced in Ontario. Provide selection criteria used.

.4 Manufacturer's Installation Instructions: Indicate special procedures, and external controls.

1.6 QUALITY ASSURANCE

.1 Manufacturer: Company specializing in manufacturing the products specified in this section with minimum ten years' documented experience.

.2 Design expansion compensating system under direct supervision of a Professional Engineer experienced in design of this work and licenced in the Province of Ontario.

.3 Welding and brazing: ASME BPVC Section IX.

.4 Metallic materials: ASME BPVC Section II

.5 Non-destructive examination (NDE): ASME BPVC Section V

.6 Provide products having CRN Ontario or CRN Canada where rated pressure is in excess of 14.5 psig (1 bar).

.7 Unless otherwise specified, provide certification of hydrotesting at 150% of design pressure for 10 minutes to ASME B31.1 as a minimum.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Transport, handle, store, and protect products.

.2 Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.

.3 Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.8 WARRANTY

.1 Warranty: 5-year replacement warranty.

1.9 EXTRA MATERIALS

.1 Section 22 01 01: Submittals for project closeout.

.2 Provide two 340 gm containers of packing lubricant and cartridge style grease gun for slip-type expansion joints.

2 PRODUCTS

2.1 MANUFACTURERS

.1 Metal expansion joints and compensators

- .1 Flex-Pression Ltd.
- .2 Senior Flexonics
- .3 Triad Bellows
- .4 Flextech Industries
- .5 US Bellows
- .6 Metraflex

.2 Elastomeric expansion joints and compensators

- .1 Proco Products
- .2 Metraflex
- .3 Flextech

2.2 PIPE ALIGNMENT GUIDES

.1 Copper Pipe:

- .1 Radial "spider" type, minimizing piping motions in non-axial planes.
- .2 Constructed of carbon steel with non-metallic coating on the tube clamps, and a 360-degree two-piece bolted housing, and 360-degree two-piece bolted clamps with spider type legs.
- .3 Provide an insulation clearance of 1.5".
- .4 Provide from same manufacturer as any associated expansion joints or compensators.

.2 Steel Pipe:

.1 Radial "spider" type, minimizing piping motions in non-axial planes.

.2 Constructed of carbon steel with a 360-degree two-piece bolted housing, and 360-degree two-piece bolted clamps with spider type legs.

.3 Provide an insulation clearance of 1.5" on sizes 6" IPS and under, and 2.0" on sizes 8" IPS and over.

.4 Provide from same manufacturer as any associated expansion joints or compensators.

2.3 FLEXIBLE PIPE CONNECTORS

.1 Copper Piping:

.1 Inner Hose: Bronze

.2 Exterior Sleeve: Braided bronze.

.3 Pressure Rating: 125 psi (862 kPa) WSP and 450°F (232°C).

.4 End fittings: As specified for pipe joints.

.2 Steel Piping, 2" (50 mm) diameter and smaller:

.1 Inner Hose: T316 or T321 stainless steel.

.2 Exterior Sleeve: T304 braided stainless steel.

.3 Pressure Rating: 125 psi (862 kPa) WSP and 450°F (232°C).

.4 End fittings: NPT threaded, ASTM A105.

.3 Steel Piping, 2-1/2" to 3-1/2" (65mm to 90mm) diameter :

.1 Inner Hose: T316 or T321stainless steel

.2 Exterior Sleeve: T304 braided stainless steel.

.3 Pressure Rating: 125 psi (862 kPa) WSP and 450°F (232°C).

.4 End fittings: CL150 flanged, A105, B16.5 RF one end, CL150 flanged A516-70, B16.5 drilling lap joint flange one end.

.4 Steel Piping, 4" (100mm) diameter and larger:

.1 Inner Hose: T321 stainless steel.

.2 Exterior Sleeve: T304 braided stainless steel.

.3 Pressure Rating: 125 psi (862 kPa) WSP and 450°F (232°C).

.4 End fittings: CL150 A105 flanged B16.5 one end, CL150 A516-70 flanged B16.5 drilling lap joint flange one end.

2.4 EXPANSION JOINTS - COPPER PIPING

.1 Bronze Bellows Type Compensator:

.1 Construction: 2-ply bronze externally pressurized type with anti-torque device, limit stops, internal guides.

.2 Pressure Rating: 125 psi (862 kPa) WSP and 400°F (204°C).

.3 Maximum Compression: 1-3/4" (45 mm).

.4 Maximum Extension: 1/4" (6 mm).

.5 End fittings: soldered.

.6 Application: Copper piping.

2.5 EXPANSION JOINTS - DESIGN 150 PSIG / 500°F – STEEL PIPING

.1 Design Criteria

.1 Test Pressure: to ASME B31.1.

.2 EJMA Cycles: 2000

.2 Externally Pressurized Compensator

.1 Pressure Rating: 150 psi (1035 kPa) WOG and 500°F (260°C).

.2 Maximum Compression: 1-3/4" (45 mm).

.3 Maximum Extension: 1/4" (6 mm).

.4 ASTM A240 T316 or T321 stainless steel bellows.

.5 ASTM A106 shroud and pipe.

.6 ASTM 516-70 plate rings.

.7 ASTM A105 3000# weld-o-let drain connection and plug.

.8 End fittings: CL150, A105 flanged B16.5 RF each end.

.9 Provide anchor base as required.

.10 Application: Steel piping 2-1/2" (65 mm) and smaller.

.3 Externally Pressurized

.1 Pressure Rating: 150 psi (2070 kPa) WOG and 500°F (260°C).

.2 Maximum Compression: 8" (200 mm).

.3 Maximum Extension: 2" (50 mm).

.4 ASTM A240 T316 or T321 stainless steel bellows.

.5 ASTM A106 shroud and pipe.

.6 ASTM 516-70 plate rings.

.7 ASTM A105 3000# weld-o-let drain connection and plug.

.8 End fittings: CL150, A105 flanged B16.5 RF each end.

.9 Provide anchor base as required.

.10 Application: Steel piping 3" (75 mm) and larger.

.4 Controlled Flexing

.1 Pressure Rating: 150 psi (2070 kPa) WOG and 500°F (260°C).

.2 Maximum Compression: 4" (200 mm).

.3 Maximum Extension: 1" (25 mm).

.4 ASTM A240 T304 or T316 stainless steel bellows.

.5 Cast iron bolted control rings between each bellows corrugation and cast iron neck flanges.

.6 End fittings: CL150, B16.5 vanstoned A516-70 steel plate flanges each end.

.7 Application: Steel piping 3" (75 mm) and larger.

.8 Provide liner for steam service.

2.6 SLIP-TYPE EXPANSION JOINT

.1 Pressure Rating: 150 psi (2070 kPa) WOG and 500°F (260°C).

.2 Maximum Compression: 4" (200 mm).

.3 Maximum Extension: 1" (25 mm).

.4 Packed-slip type containing injectable flaked graphite packing and graphite seals. Packing ports allowing packing under full line pressure are required.

.5 Internal and external line-bore machined guides of ASTM B169-C614 bronze.

.6 Stainless steel extension limit stop ring covering approximately 360 degrees will be included on each slip tube.

.7 ASTM A106 slip tube hard-chromed-plated .002" thick to ASTM B650.

.8 One-piece body, steel construction ASTM A106 and ASTM A516-70.

.9 Drain port on each joint.

.10 End fittings: CL150, A105 flanged B16.5 RF each end.

.11 Provide anchor base as required.

.12 Joint design and manufacturing in compliance with ASTM F1007 and MIL-E-17814F.

3 EXECUTION

3.1 INSTALLATION

.1 Install flexible pipe connectors and expansion joints to manufacturer's

instructions.

.2 Ensure ratings and bolt patterns for flanges suit design pressure and design temperature of piping system and match those of installed components.

.3 Provide spool pieces as required.

.4 Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Provide line size flexible connectors.

.5 Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.

.6 Provide pipe anchors securing the piping system to the building structure to control the direction and the amount of pipe movement. Design pipe anchors to withstand expansion joint thrust forces, spring forces, and other forces experienced. Prepare calculations for each anchor and submit to Consultant for review and approval.

.7 Provide pipe guides at spacings recommended by expansion joint manufacturer to maintain pipe alignment and ensure pipe expansion is directed along the proper axes relative to the expansion joint. Ensure two guides are provided on each side of an expansion joint.

.8 Provide support and equipment required to control expansion and contraction of piping. Provide pipe offsets, and swing joints, or expansion joints where required.

.9 Expansion loops in place of expansion compensators where there is adequate space to do so is acceptable subject to the approval of the Consultant. Prepare and submit detailed design calculations for each expansion loop proposed to the Consultant for review and approval prior to installation.

3.2 MANUFACTURER'S FIELD SERVICES

.1 Prepare and start systems to Section 22 01 01.

.2 Provide inspection services by manufacturer's representative for final installing and certify installation is to manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 22 01 01.

1.2 SECTION INCLUDES

.1 Pipe and equipment hangers and supports.

.2 Sleeves and seals.

.3 Flashing and sealing equipment and pipe stacks.

1.3 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B31.5 - Refrigeration Piping and Heat Transfer Components.

.2 ASME B31.9 – Building Services Piping.

.2 ASTM International (ASTM)

.1 ASTM F708 - Design and Installation of Rigid Pipe Hangers.

.3 American National Standards Institute (ANSI)

.1 MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.

.2 MSS SP69 - Pipe Hangers and Supports - Selection and Application

.3 MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices

.4 CSA Group (CSA)

.1 CSA B51 - Boiler, pressure vessel, and pressure piping code

.5 Underwriters Laboratories (UL)

.1 UL 203 - Pipe Hanger Equipment for Fire protection Service.

1.4 SHOP DRAWING SUBMITTALS

.1 Section 22 01 01: Procedures for submittals.

.2 Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

.3 Product Data: Provide manufacturers’ catalogue data including load capacity.

.4 Design Data: Indicate load carrying capacity of trapeze, multiple pipes, and riser support hangers.

.5 Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.5 REGULATORY REQUIREMENTS

.1 Conform to CSA B-51 for support of piping.

.2 Conform to the requirements of ASME B31.9.

1.6 DELIVERY, STORAGE, AND HANDLING

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

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

.1 Provide products conforming to applicable MSS SP standards.

.2 Manufacturers:

- .1 Anvil
- .2 Myatt
- .3 Hunt

.3 Plumbing and Natural Gas Piping:

- .1 Hangers for Pipe Sizes 1/2" to 1-1/2" (13 to 38 mm): Carbon steel, adjustable swivel, split ring.
- .2 Hangers for Cold Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.
- .3 Hangers for Hot Pipe Sizes 2" to 4" (50 to 100 mm): Carbon steel, adjustable, clevis.
- .4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- .5 Wall Support for Pipe Sizes to 3" (76 mm): Cast iron hook.
- .6 Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- .7 Floor Support for Hot Pipe Sizes to 4" (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.8 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.2 ACCESSORIES

.1 Hanger Rods: galvanized, carbon steel continuous threaded.

.2 Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.3 SLEEVES

.1 Materials:

.1 Cast iron pipe with annular fin.

.2 Steel pipe with annular fin continuously welded at midpoint.

.3 20-Ga galvanized steel

2.4 FLASHINGS AND COUNTERFLASHINGS

.1 Thaler or equivalent mechanical/electrical flashings as recommended for specific purpose.

.2 Stainless steel flashing sleeve, integral deck flange and EPDM seal.

3 EXECUTION

3.1 INSTALLATION

.1 Install according to manufacturer's instructions and best trade practises.

.2 Conform to the requirements of applicable MSS SP standards supplementary to manufacturer’s instructions.

3.2 INSERTS

.1 Provide inserts for placement in concrete formwork.

.2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

.3 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

.4 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

3.3 PIPE HANGERS AND SUPPORTS

.1 Support horizontal piping as scheduled.

.2 Install hangers to provide minimum 1/2" (13 mm) space between finished

covering and adjacent work.

.3 Place hangers within 12" (300 mm) of each horizontal elbow.

.4 Use hangers with 1-1/2" (38 mm) minimum vertical adjustment.

.5 Support horizontal cast iron pipe adjacent to each hub, with 5 feet (1.5 m) maximum spacing between hangers.

.6 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

.7 Provide copper plated hangers and supports for copper piping.

.8 Design hangers for pipe movement without disengagement of supported pipe.

.9 Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

.10 Prepare accurate weight balance calculations to determine the required supporting force at each hanger location and the pipe weight load at each equipment connection.

.11 Ensure hangers and supports can support the pipe in all conditions of operation allow free expansion and contraction of the piping and prevent excessive stress resulting from transferred weight being induced into the pipe or connected equipment.

.12 Wherever possible, provide pipe clamps for pipe attachments for horizontal piping.

.13 Wherever possible, provide beam clamps for structural attachment.

.14 Support from top of structural members. Where structural bearings do not exist or inserts are not available in suitable locations, suspend hangers from steel channels or angles. Provide supplementary structural members as needed. Obtain approval before using vertical expansion shields. Use minimum two shields for each hanger. Do not suspend from metal deck.

.15 Provide a means of vertical adjustment after erection. Use hangers with 1-1/2" (38 mm) minimum vertical adjustment.

.16 Design hangers that they cannot become disengaged by movements of the supported pipe.

.17 Where practical, support riser piping independently of the connected horizontal piping. Provide riser clamp lugs for pipe support attachments to the riser piping. Provide welded attachments of material comparable to that of the pipe and designed in accordance with governing codes.

.18 Support vertical piping at every other floor. Support vertical cast iron pipe at each floor at hub.

.19 Ensure hanger rods are subject to tensile loading only. At hanger locations

where lateral or axial movement is anticipated, provide suitable linkage to permit swing.

.20 Where horizontal piping movements are greater than 1/2" (13 mm), or where the hanger rod angularity from the vertical is greater than 4 degrees from the cold to hot position of the pipe, Offset the hanger pipe and structural attachments in such manner that the rod is vertical in the operating position.

.21 Install rigid hangers with adjustable devices where ratio of pipe expansion to hanger rod length does not exceed 1:24.

.22 Install swing hanger with adjustable devices where ratio of pipe expansion to hanger rod length does not exceed 1:6.

.23 Install pipe rollers (roller hangers) for steam and condensate, piping 4" (100 mm) in diameter and larger and where ratios cannot be maintained.

.24 Install spring hangers on horizontal runs where required to offset vertical expansion of risers.

.25 Support horizontal piping in accordance with code requirements. Where there are no code requirements, provide support and spacing as shown in schedule with following exceptions:

.1 Support plumbing piping in accordance with Ontario Building Code Part 7, Plumbing.
.2 Support 1/2" (13 mm) gas pipe every 6' (1.8 m).
.3 Support 1/2" (13 mm) copper pipe every 5' (1.5 m).
.4 Support flexible joint roll grooved pipe in accordance with table below, but not less than one hanger for each joint.
.5 Support plastic piping in accordance with manufacturer's recommendations.

.26 Install hangers to provide minimum 1/2" (13 mm) space between finished covering and adjacent work.

.27 Place hangers within 12" (300 mm) of each horizontal elbow.

.28 Support horizontal cast iron pipe adjacent to each hub, with 5 feet (1.5 m) maximum spacing between hangers.

3.4 SLEEVES

.1 Set sleeves in position in formwork. Provide reinforcing around sleeves.

.2 Size sleeves to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

.3 Extend sleeves through floors 1" (25 mm) above finished floor level. Caulk sleeves.

.4 Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with stuffing insulation and caulk. Provide close fitting metal collar or escutcheon covers at both sides of

penetration.

.5 Install chrome plated steel escutcheons at finished surfaces.

3.5 FLASHING

.1 Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

.2 Flash vent and soil pipes projecting 3" (75 mm) minimum above finished roof surface with lead worked 1" (25 mm) minimum into hub, 8" (200 mm) minimum clear on sides with 24" x 24" (600 x 600 mm) sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter flash, and seal.

.3 Flash floor drains in floors with topping over finished areas with lead, 10" (250 mm) clear on sides with minimum 36" x 36" (910 x 910 mm) sheet size. Fasten flashing to drain clamp device.

.4 Seal roof, floor, shower and mop sink drains watertight to adjacent materials.

.5 Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed to manufacturer's instructions for sound control.

.6 Provide curbs for mechanical roof installations 14" (350 mm) minimum high above roofing surface. Flash and counter flash with sheet metal; seal watertight. Attach counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.

.7 Adjust storm collars tight to pipe with bolts, caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

.8 Coordinate this work with the roofing Trades to ensure a satisfactory installation and to avoid delays.

3.6 SCHEDULES

.1 Imperial Measure (IP)

Pipe Size (in)	Rod Diameter (in)	Support Spacing (Ft)	
		Steel Pipe	Copper Tube
1/2	3/8	7	6
3/4	3/8	7	6
1	3/8	7	6
1-1/4	3/8	7	6
1-1/2	3/8	9	8
2	3/8	10	9

2-1/2	3/8	12	10
3	3/8	12	10

.2 Metric Measure (SI)

Pipe Size (mm)	Rod Diameter (mm)	Support Spacing (m)	
		Steel Pipe	Copper Tube
13	10	2.1	1.8
20	10	2.1	1.8
25	10	2.1	1.8
32	10	2.1	1.8
38	10	2.7	2.4
50	10	3	2.7
65	10	3.6	3
75	10	3.6	3

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 22 01 01.

1.2 SECTION INCLUDES

.1 Testing, adjustment, and balancing of piping systems.

1.3 REFERENCE STANDARDS

.1 AABC - National Standards for Total System Balance.

.2 NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.4 SUBMITTALS

.1 Submit name of adjusting and balancing agency for approval within 30 days after award of Contract.

.2 Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

.3 Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.

.4 Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Consultant and for inclusion in operating and maintenance manuals.

.5 Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty prior to commencing system balance.

.6 Test Reports: Indicate data on AABC National Standards for Total System Balance forms.

1.5 PROJECT RECORD DOCUMENTS

.1 Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

.2 Record actual locations of flow measuring stations.

1.6 QUALITY ASSURANCE

.1 Perform total system balance to AABC National Standards for Field Measurement and Instrumentation, Total System Balance.

.2 Maintain one copy of each document on site.

1.7 QUALIFICATIONS

.1 Agency: Company specializing in the testing, adjusting, and balancing of systems under this Section with minimum five years documented experience certified by AABC or prequalified as listed below.

.2 Performed Work under the supervision of an AABC certified Test and Balance Engineer, an NEBB Certified Testing, Adjusting and Balancing Supervisor or a registered Professional Engineer experienced in the performance of this work and licenced at the place where the Project is located.

1.8 PRE-BALANCING CONFERENCE

.1 Convene one week prior to commencing work of this Section.

1.9 CO-OPERATION

.1 Co-operate with installing Contractor(s) in advising them of specific scheduling requirements for systems verification.

.2 Provide advice to installing Contractors regarding the location and installation of devices required to permit system balancing and measurements, prior to start of the installation work.

.3 TAB Contactor responsible for 22 05 93 and TAB Contractor responsible for 23 05 93 are required to work in conjunction with each other to achieve a fully balanced and functional HVAC system. Where two separate contractors are used, the General Contractor is responsible for coordinating this work.

2 PRODUCTS

2.1 REFERENCE STANDARDS

.1 Ensure equipment required for the verification of equipment and systems is furnished by the agency employed to conduct the Plumbing Systems Verification.

.2 Testing and measuring equipment used in the verification of the plumbing systems shall be calibrated to give true readings within the accuracy specifications of the equipment used. A certificate of calibration from an independent testing laboratory may be required by the Consultant if there is any reason to suspect that the equipment used is giving erroneous readings. In such an event the verification agency shall reconduct its verifications.

.3 Equipment used by the agency in its verification of plumbing systems remains the property/responsibility of the agency and is not included in the supply to the project.

3 EXECUTION

3.1 EXAMINATION

.1 Verify that systems are complete and operable before commencing work. Ensure

the following conditions:

.1 Systems are started and operating in a safe and normal condition.

.2 Plumbing systems are flushed, filled, and vented.

.3 Service and balance valves are open.

.2 Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.

.3 Beginning of work represents acceptance of existing conditions in the areas served.

3.2 PREPARATION

.1 Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Consultant to facilitate spot checks during testing.

.2 Provide additional balancing devices as required.

3.3 INSTALLATION TOLERANCES

.1 Domestic Hot Water Recirculation Systems: Adjust to within plus or minus 10 percent of design.

3.4 ADJUSTING

.1 Ensure recorded data represents actual measured or observed conditions.

.2 Permanently mark settings of valves other adjustment devices allowing settings to be restored. Set and lock memory stops.

.3 After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

3.5 DOMESTIC HOT WATER RECIRCULATION SYSTEM PROCEDURE

.1 Adjust water systems to provide required or design quantities.

.2 Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance.

.3 Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

.4 Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.6 SCHEDULES

.1 Equipment requiring testing, adjusting and balancing:

.1 Balancing valves

.2 Report Forms

.1 Title Page:

.1 Name of Testing, Adjusting, and Balancing Agency

.2 Address of Testing, Adjusting, and Balancing Agency

.3 Telephone number of Testing, Adjusting, and Balancing Agency

.4 Project name

.5 Project location

.6 Project Architect

.7 Project Engineer

.8 Project Contractor

.9 Project altitude

.10 Report date

.2 Summary Comments:

.1 Design versus final performance

.2 Notable characteristics of system

.3 Description of systems operation sequence

.4 Nomenclature used throughout report

.5 Test conditions

3.7 PIPING SYSTEMS VERIFICATION

.1 Review the drawings, specifications, and installed work to ensure that systems may be properly balanced in accordance with drawings. Advise the installing Contractor of any additional requirements for effective balancing.

.2 Open all valves to full position, including coil stop valves, close bypass valves, and return line

.3 Examine water in system to determine if it has been treated and is clean.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 22 01 01.

1.2 SECTION INCLUDES

.1 Piping insulation.

.2 Jackets and accessories.

1.3 REFERENCE STANDARDS.

.1 American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE)

.1 Standard 90.1-2013—Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings

.2 ASTM International (ASTM)

.1 ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.

.2 ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

.3 ASTM C195 - Mineral Fibre Thermal Insulating Cement.

.1 ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.

.4 ASTM C449/C449M - Mineral Fibre Hydraulic-setting Thermal Insulating and Finishing Cement.

.5 ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Metre Apparatus.

.6 ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.

.7 ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

.8 ASTM C547 - Mineral Fibre Pipe Insulation.

.9 ASTM C552 - Cellular Glass Thermal Insulation.

.10 ASTM C578 - Rigid, Cellular Polystyrene Thermal Insulation.

.11 ASTM C585 - Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).

.12 ASTM C591 - Unfaced Preformed Cellular Polyisocyanurate Thermal Insulation.

.13 ASTM C610 - Moulded Expanded Perlite Block and Pipe Thermal Insulation.

.14 ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.

.15 ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.

.16 ASTM D1667 - Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Closed Cell Foam).

.17 ASTM D2842 - Water Absorption of Rigid Cellular Plastics.

.18 ASTM E84 - Surface Burning Characteristics of Building Materials.

.19 ASTM E96 - Water Vapour Transmission of Materials.

.3 Standards Council of Canada (SCC)

.1 CAN/ULC-S102 – Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

.4 National Fire Protection Association (NFPA)

.1 NFPA 255 - Surface Burning Characteristics of Building Materials.

.5 Thermal Insulation Association of Canada (TIAC)

.1 TIAC Mechanical Insulation Best Practices Guide.

.6 Underwriters Laboratories (UL)

.1 UL 723 - Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

.1 Product Data: Provide product description, list of materials and thickness for each service, and locations.

.2 Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

.1 Materials: Flame spread/smoke developed rating of 25/50 or less to CAN/ULC S102 and ASTM E84.

1.6 QUALIFICATIONS

.1 Applicator: Company specializing in performing the work of this section with minimum three years experience.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Transport, handle, store, and protect products.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.

.3 Store insulation in original wrapping and protect from weather and construction traffic.

.4 Protect insulation against dirt, water, chemical, and mechanical damage.

1.8 ENVIRONMENTAL REQUIREMENTS

.1 Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

.2 Maintain temperature during and after installation for minimum period of 24 hours.

2 PRODUCTS

2.1 GLASS FIBRE

.1 Manufacturers:

.1 Manufacturer: Owens Corning Fiberglass

.2 Other acceptable manufacturers offering equivalent products:

.1 Manson

.2 Knauf Fiber Glass

.3 Johns Manville

.3 Insulation: ASTM C547; rigid moulded, noncombustible.

.1 'ksi' value: ASTM C335, 0.035 at 75°F (24°C).

.2 Minimum Service Temperature: -20°F (-28.9°C).

.3 Maximum Service Temperature: 302°F (150°C).

.4 Maximum Moisture Absorption: 0.2 percent by volume.

.4 Vapour Barrier Jacket

.1 ASTM C921, White kraft paper reinforced with glass fibre yarn and bonded to aluminized film.

.2 Moisture Vapour Transmission: ASTM E96; 0.02 perm.

.3 Secure with self-sealing longitudinal laps and butt strips.

.4 Secure with outward clinch expanding staples and vapour barrier mastic.

.5 Tie Wire: 1.3 mm stainless steel with twisted ends on maximum 12" (300 mm) centres.

.6 Vapour Barrier Lap Adhesive

.1 Compatible with insulation.

.7 Insulating Cement/Mastic

.1 ASTM C195; hydraulic setting on mineral wool, VOC content not to

exceed 80 g/L.

.8 Fibrous Glass Fabric

.1 Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.

.2 Blanket: 1.0 lb/cu ft (16 kg/cu m) density.

.9 Indoor Vapour Barrier Finish

.1 Vinyl emulsion type acrylic, compatible with insulation, white colour, VOC content not to exceed 250 g/L.

.10 Outdoor Vapour Barrier Mastic

.1 Vinyl emulsion type acrylic, compatible with insulation, white colour.

.11 Insulating Cement

.1 ASTM C449, VOC content not to exceed 80 g/L.

2.2 JACKETS

.1 PVC Plastic

.1 Jacket: ASTM C921, One piece moulded type fitting covers and sheet material.

.1 Minimum Service Temperature: -31°F (-35°C).

.2 Maximum Service Temperature: 151°F (66°C).

.3 Moisture Vapour Transmission: ASTM E96; 0.03 perm inches.

.4 Thickness: 20 mil (0.4 mm) minimum.

.2 Colour: standard off-white

.3 Covering Adhesive Mastic

.1 Compatible with insulation, maximum VOC content of 50 g/L.

.4 Manufacturer.

.1 Ceel-Co 300 series

.2 Speedline *Smoke Safe*

.2 Aluminum Jacket: ASTM B209.

.1 Thickness: 0.02" (0.40 mm) sheet.

.2 Finish: Smooth.

.3 Joining: Longitudinal slip joints and 2" (50 mm) laps.

.4 Fittings: 0.02" (0.40 mm) thick die shaped fitting covers with factory attached protective liner.

.5 Metal Jacket Bands: 3/8" (10 mm) wide; 0.01" (0.38 mm) thick aluminum.

2.3 ACCESSORIES

.1 Provide adhesives and finishes as recommended by the insulation manufacturer. Ensure accessories such as adhesives, mastics and cements have the same properties as listed above and do not detract from system ratings specified.

.2 Vapor retarder lap adhesive - water based, fire retardant

.3 Tapes - cloth reinforced aluminum, soft adhesive with minimum 2" (50 mm) width.

.4 Tie wire -1/16" (1.5 mm) ø stainless steel.

.5 Fasteners - 1/8" (4 mm) Ø pins, with 35 mm square clips. Clip length to suit insulation thickness.

.6 Bands - 1/2" (12 mm) wide 1/4" (6mm) thick galvanized steel.

.7 Facing - 1" (25 mm) galvanized steel hexagonal wire mesh attached on both faces of insulation.

3 EXECUTION

3.1 EXAMINATION

.1 Verify that piping has been tested before applying insulation materials.

.2 Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

.1 Install piping insulations to TIAC National Installation Standards.

.2 Apply insulation materials, accessories, jackets and finishes in accordance with manufacturers' written instructions and as specified.

.3 On exposed piping locate insulation and cover seams in least visible locations.

.4 Insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:

.1 Provide vapour barrier jackets, factory applied, or field applied.

.2 Insulate fittings, joints, and valves with moulded insulation of like material and thickness as adjacent pipe.

.3 Finish with glass cloth and vapour barrier adhesive.

.4 PVC fitting covers may be used.

.5 Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.

.6 Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

.5 For insulated pipes conveying fluids above ambient temperature:

.1 Provide standard jackets, with or without vapour barrier, factory applied, or field applied.

.2 Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.

.3 Finish with glass cloth and adhesive.

.4 PVC fitting covers may be used.

.5 For hot piping conveying fluids 140°F (60°C) or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

.6 For hot piping conveying fluids over 140°F (60°C), insulate flanges and unions at equipment.

.6 Inserts and Shields:

.1 Application: Piping 1-1/2" (40 mm) diameter or larger.

.2 Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.

.3 Insert Location: Between support shield and piping under the finish jacket.

.4 Insert Configuration: Minimum 6" (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.

.5 Insert Material: hydrous calcium silicate insulation.

.7 Finish insulation at supports, protrusions, and interruptions.

.8 Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapour barrier cement.

3.3 PIPE INSULATION

.1 Insulate new or altered piping with rigid pipe insulation and re-insulate existing piping where insulation has been removed or damaged as follows:

RIGID PIPE INSULATION			
Service	**Operating Temperature Range °F**	**Pipe Diameter in.**	**Insulation Thickness in.**
Domestic cold water	32 to 105	All sizes	1
Domestic hot water & hot water recirculation	105 to 140	1-1/2 and smaller	1
		2 and larger	1-1/2
Storm drainage	40 to 55	All sizes	1
Humidifier piping	201 to 250	3 and smaller	2-1/2

RIGID PIPE INSULATION (SI)			
Service	**Operating Temperature Range °C**	**Pipe Diameter (mm)**	**Insulation Thickness (mm)**
Domestic cold water	0 to 40	All sizes	25
Domestic hot water & hot water recirculation	41 to 60	38 and smaller	25
		50 and larger	38
Storm drainage	4 to 13	All sizes	25
Humidifier piping	94 to 121	75 and smaller	65

.2 Insulate valves, flanges and pipe connections with removable / reusable insulation covers.

.3 Wrap butt joints with a 4" (100 mm) strip of fire resistant vapour barrier jacket cemented with lagging adhesive.

.4 Where the pipe hanger is around the insulation, provide an insulation protection shield within the pipe saddle. Coordinate with installation of hangers.

.5 Insulate fittings, flanges and valves on pipes to provide equivalent insulation to that on adjoining pipe.

.6 Continue insulation through sleeves including specified finish.

.7 Cut back covering on strainers and finish off to expose removable head insulation.

.8 Cover expansion joints first with 24 gauge (0.7 mm) galvanized metal sleeve and then insulate to provide equivalent thickness to that on adjoining pipe.

.9 Protect insulation with protection saddles where insulated pipe is supported by rollers.

.10 Insulate pipe hangers supporting new piping carrying water at 70°F (21°C) or less to prevent condensation. Extend insulating material along hanger rod to height 4 times thickness of insulation. Seal insulation with vapour-proof sealant.

.11 Extend pipe insulation and coverings through walls, floors, ceilings, and concrete beams, unless indicated otherwise on drawings. protect exposed insulation extending through floors with 4" (100 mm) wide strip of 18 gauge (1.3 mm) galvanized iron.

.12 Pack annular space between pipe sleeves and piping or pipe covering with glass fibre insulation or rockwool insulation. In fire rated assemblies use Dow Silicon RTV or other ULC listed materials. Seal exposed insulation with mastic.

.13 Recover exposed surfaces of insulated piping installed in exposed areas, mechanical rooms, and equipment rooms with PVC jacketing and PVC fitting covers installed in accordance with manufacturers instructions.

.14 Insulate and cover exposed surfaces of waste connections, traps, and valves at each lavatory and sink designated for "handicapped" or "barrier free" use with: PVC insulated fitting covers specifically designed for this application. Vinyl material is not to exceed flame spread rating of 150, and if intended to be used in high buildings, its smoke developed classification does not exceed 300. Zeston or other equivalant material. or foamed plastic type insulation finished with two coats of Armstrong Armflex or other equivalent material.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 22 01 01 and 01 91 00.

1.2 COMMISSIONING AGENT

.1 A commissioning agent has been contracted directly by the Owner for this project. The CA has overall responsibility for planning and coordinating the commissioning process. Commissioning involves all parties to the design and construction process, including the Contractor and his sub-contractors and suppliers.

1.3 DESCRIPTION OF WORK

.1 The purpose of the commissioning process is to provide the owner/operator of the facility with assurance that the plumbing systems have been installed according to the contract documents and operate within the performance guidelines set out in the design intent documents and these specifications. The CA will provide the Owner with an unbiased, objective view of the system's installation, operation, and performance. The commissioning process does not take away or reduce the responsibility of the installation contractors to provide a finished product, installed and fully functional in accordance with the contract documents.

.2 Commissioning is intended to enhance the quality of system start up and aid in the orderly completion and transfer of systems for beneficial use of owner. The CA will be the leader of the commissioning team, planning and coordinating all commissioning activities in conjunction with the design professionals, construction manager, subcontractors, manufacturers and equipment suppliers.

.3 The General Contractor and Division 21, 22, 23, 25, 26, 27 and 28 sub-contractors are responsible for cooperating, and coordinating their work, with the CA. They shall also be responsible for carrying out all the physical activities required for installation of components and systems and operating them during the commissioning process as required in this Section.

1.4 RELATED DOCUMENTS

.1 Drawings and General Requirements of the contract, including General and Supplementary General Conditions, General Requirements and applicable Sections of Divisions 21, 22, 23, 25, 26, 27 and 28 apply to work of this Section.

.2 Refer to Commissioning Specifications indicated in Appendix C.

1.5 REFERENCE STANDARDS

.1 American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE)

.1 ASHRAE Guideline 0 The Commissioning Process

1.6 SYSTEMS TO BE COMMISSIONED

.1 The following Plumbing work shall be commissioned as part of the Work of this contract:

.1 Domestic hot water heater

.2 Domestic hot water recirculation system

.3 Domestic hot and cold water supply systems

.4 Sanitary drainage systems

.5 Pipe testing

2 PRODUCTS

2.1 COMMISSIONING AUTHORITY

.1 The commissioning authority shall consist of representatives of the following:

.1 Owner and the Owner's Operating and Maintenance Staff

.2 Architect

.3 Mechanical Design Engineer

.4 Electrical Design Engineer

.5 Commissioning Agent (CA)

.6 General Contractor

.7 Division 22 Subcontractor

.8 Testing, Adjusting and Balancing Agency

.9 Related Subcontractors and Suppliers.

2.2 SYSTEMS START-UP/VERIFICATION CHECKLISTS

.1 The Appendix specification section contains the system start-up and verification checklists as listed below:

.1 Domestic water supply systems

.2 Domestic hot water supply systems

.3 Storm drainage systems

.4 Sanitary drainage systems

.5 Pipe testing

2.3 FUNCTIONAL PERFORMANCE TEST CHECKLISTS

.1 The Appendix specification section contains functional performance test checklists as listed below:

.1 Domestic water supply systems including cisterns

.2 Domestic hot water supply systems

.3 Storm drainage systems

.4 Sanitary drainage systems

.5 Pipe testing

3 EXCECUTION

3.1 COMMISSIONING AGENT (CA) RESPONSIBILITIES

.1 Plan, organize and implement the commissioning process as specified.

.2 Prepare the commissioning plan, ensure its distribution for review and comment.

.3 Revise the commissioning plan as required during construction.

.4 Chair commissioning meetings and prepare and distribute minutes to commissioning team members.

.5 In conjunction with the General Contractor, coordinate commissioning activities among contractors, sub-trades and suppliers.

.6 monitor system verification checks, and ensure the results are documented as the checks are done.

.7 Observe start-ups and initial system operations tests and checks.

.8 Witness functional performance tests and document the results.

.9 Prepare and submit a commissioning report which documents checks and tests done throughout the commissioning process.

.10 Ensure O&M manuals, instructions and demonstrations are provided to the owner's designated operating staff.

3.2 MECHANICAL ENGINEER'S RESPONSIBILITES

.1 The Mechanical Engineer will review the commissioning plan, and will participate, as appropriate, in on-site commissioning meetings.

.2 During the acceptance phase of the commissioning process, the Mechanical Engineer may be on site to review commissioning documentation, to witness functional performance tests, and to analyze the installation and its performance.

3.3 OWNER'S RESPONSIBILITIES

.1 The Owner will ensure the availability of operating staff for scheduled instructions and demonstration sessions. This staff will possess sufficient skills and knowledge to operate and maintain the installation following attendance at these sessions. The owner will also ensure the appropriate involvement of the Electrical Engineer, Architect, and any other consultants as required, in the commissioning process.

3.4 GENERAL CONTRACTOR'S RESPONSIBILITES

.1 Participate as required in the Mechanical Systems Commissioning process,

.2 Ensure the Division 22 sub-contractor performs assigned commissioning responsibilities as specified.

.3 Ensure the testing, adjusting and balancing agency performs assigned commissioning responsibilities as specified.

.4 Ensure the cooperation and participation in the commissioning process of other sub-contractors as applicable.

.5 Assign a representative to the commissioning team, and submit the person's name to the commissioning agency, within one (1) month of the award of the contract. The representative shall have the authority to make decision on behalf of the general contractor as they relate to the organization and scheduling of plumbing systems commissioning. The representative shall facilitate communications among all contractors and suppliers and other commissioning team members and shall foster the necessary cooperative action. One specific responsibility shall be to attend commissioning meetings and ensure action items arising from them are attended to as required to allow the commissioning process to proceed on schedule.

.6 In the event that any scheduled equipment or system start-ups or functional performance tests are terminated because the CA or the mechanical engineer discover deficient or incomplete work, or due to the non-attendance of required contractor or supplier personnel, the contractor or sub-contractor responsible for the termination shall also be responsible for paying reasonable costs of time and travel expenses of any or all of the following representatives who were physically present for the purpose of witnessing the start-up or the functional performance test including the CA, the mechanical engineer, the electrical engineer, and the owner. The owner may provide a statement to the General Contractor identifying the specific activity that was terminated, the scheduled date, and a list of those in attendance, along with their reasonable time and travel expenses.

3.5 DIVISION 22 SUBCONTRACTOR'S RESPONSIBILITIES

.1 Cooperate with the commissioning agent (CA), and other commissioning team members, to facilitate the successful completion of the commissioning process.

.2 Assign a representative to the commissioning team, and submit the person's name to the commissioning agency, within one (1) month of the award of the contract. The representative shall have the authority to make decisions on behalf of the mechanical contractor as they relate to the organization and scheduling of plumbing systems commissioning. The representative shall ensure communications between Division 22 contractors and suppliers and all other commissioning team members and shall foster the necessary cooperative action. One specific responsibility shall be to attend commissioning meetings and ensure action items arising from them are attended to as required to allow the commissioning process to proceed on schedule.

.3 The plumbing systems sub-contractor, and all sub-contractors and suppliers, shall cooperate with the Commissioning Agency in carrying out the plumbing systems commissioning process. In this context, the plumbing systems sub-contractor shall:

.1 Include in his bid price the cost of participating in the commissioning process as specified herein.

.2 Provide instruction and demonstrations for the Owner's designated operating staff, in

conjunction with the commissioning agency and mechanical engineer, and with the participation of qualified technicians from major equipment suppliers and the controls contractor.

.3 Include requirements for submittal data. O&M data, and training information in each purchase order or sub-contract written.

.4 Attend commissioning meetings scheduled by the CA.

.5 Notify the CA a minimum of two weeks in advance of scheduled equipment and system start-ups, so that the CA may witness system verifications, and equipment and system start-ups.

.6 Provide sufficient personnel to assist the CA as required during system verification and functional performance testing.

.7 Prior to set-up, inspect, check and confirm the correct and complete installation of equipment and systems for which system verification checklists are included in the commissioning plan. Document the results of inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and re-check until the results are satisfactory, and the system is ready for safe start-up.

.8 Notify the CA a minimum of two weeks in advance of the time for start of the TAB work. Attend the initial TAB meeting for review of the TAB procedures.

.9 Prepare preliminary schedule for mechanical system orientation and inspections. O&M Manual submission, training sessions, pipe and duct system testing, flushing and cleaning, equipment start-up TAB, and task completion for use by the CA. Update schedule as appropriate throughout the construction period.

.10 Conduct plumbing systems orientation and inspection at the equipment placement completion stage.

.11 Update drawings to as-built condition and review with the CA.

.12 Gather O&M data on all equipment, and assemble in binders as specified.

.13 Provide written notification to the general contractor (or construction manager) and CC that the following work has been completed in accordance with the contract documents and the equipment, systems and sub-systems are operating as required

.1 plumbing equipment including all tanks, pumps, fixtures and piping systems.

.2 Fire-stopping in the fire-rated construction

.14 Provide a complete set of as-built drawings and O&M manuals to the CA.

3.6 TAB AGENCY'S RESPONSIBILITIES

.1 Include costs for plumbing systems commissioning requirements in the quoted price.

.2 Attend commissioning meetings scheduled by the CA prior to, and during, on-site TAB work being done.

.3 Submit proposed TAB procedures to the CA and mechanical engineer for review and acceptance.

.4 Attend the TAB planning meeting scheduled by the CA. Be prepared to discuss the procedures that shall be followed in testing, adjusting and balancing the plumbing systems system.

.5 At the completion of the TAB work, submit the final TAB report to the mechanical contractor, submittal will be to the mechanical contractor, with general contractor, CA, and mechanical engineer notified.

.6 Participate in verification of the TAB report by the CA for verification or diagnostic purposes.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 22 01 01.

1.2 SECTION INCLUDES

.1 Roof and floor drains

.2 Hose bibs.

.3 Hydrants.

.4 Trap Seal Primers

.5 Cleanouts

.6 Water hammer arrestors

.7 Backflow Preventors

.8 Interceptors

.9 Laundry Connections.

1.3 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME)

.1 ASME A112.21.1 - Floor Drains.

.2 ASME A112.21.2 - Roof Drains.

.3 ASME A112.26.1 - Water Hammer Arrestors.

.2 ASSE International (ASSE)

.1 ASSE 1011 - Hose Connection Vacuum Breakers.

.2 ASSE 1013 - Backflow Preventers, Reduced Pressure Principle.

.3 ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types.

.3 Plumbing & Drainage Institute (PDI)

.1 PDI WH-201 - Water Hammer Arrestors.

1.4 SUBMITTALS FOR REVIEW

.1 Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.

.2 Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.

1.5 SHOP DRAWING SUBMITTALS

.1 Product Data: Provide manufacturers literature including general assembly, type, materials, dimensions, connection information, approvals and capacity rating.

1.6 CLOSEOUT SUBMITTALS

.1 Project Record Documents: Record locations of equipment, cleanouts, backflow preventers, water hammer arrestors

.2 Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.7 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in a dry location, and in accordance with manufacturers' recommendations in clean, dry, well-ventilated area.

.2 Store and protect fire protection products from nicks, scratches, blemishes, theft, vandalism and vermin.

.4 Replace defective or damaged materials with new.

.5 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal

2 PRODUCTS

2.1 GENERAL

.1 Manufacturer: Watts Drainage model indicated or equivalent by:

.1 Zurn

.2 Jay R. Smith

.3 Precision Plumbing Products

2.2 ROOF DRAINS

.1 Built-Up Roofs

.1 Manufacturer: Watts Drainage Model RD100-BED-W-1.

.2 Assembly: ANSI A112.21.2.

.3 Body: Lacquered cast iron with sump.

.4 Strainer: Removable polyethylene dome with vandal proof screws.

.5 Accessories: Coordinate with roofing type, refer to Division 7:

.1 Membrane flange and membrane clamp with integral gravel stop.

.2 Adjustable under deck clamp.

.3 Roof sump receiver.

.4 Adjustable extension sleeve for roof insulation

2.3 FLOOR DRAINS

.1 Floor Drain (FD):

.1 Watts FD-100-C-5

.2 ANSI A112.21.1; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable round nickel-bronze strainer with removable perforated sediment bucket.

.2 Floor Drain (FFD):

.1 Watts Drainage Model FD-100-C-EG

.2 ANSI A112.21.1; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer with polished bronze eleongated funnel.

.3 Floor Drain (HD):

.1 Watts Drainage Model FD-100-C-AS-7-8

.2 ANSI A112.21.1; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, adjustable nickel-bronze angle strainer, trap primer tapping, and backwater valve.

2.4 BACKFLOW PREVENTOR

.1 Backflow Prevention Device Applications:

Type & Purpose	**Description**	**Installed Application**
Reduced Pressure Zone Assemblies	Two independent check valves with intermediate relief valve.	

	Supplied with shutoff valves & ball type test cocks.	Make up water for glycol fill, hot water tank, humidifier
Specialty backflow preventor with intermediate atmospheric vent	Two independent check valves with intermediate vacuum breaker and relief vent.	Ice machine
Atmospheric vacuum breaker	Single float and disc with atmospheric port.	Residential washing machine
Pressure vacuum breaker	Spring-loaded float and disc with independent check. Supplied with shutoff valves and ball type test cocks.	Autoclave
Dual Check Valve with intermediate vacuum breaker	Two independent check valves with intermediate vacuum breaker and relief vent.	Laboratory clean and dirty sinks, cup sinks, pathological workstation

.2 Reduced Pressure Zone Assemblies:

.1 Watts Model LF909.

.2 install at each cross-connection to prevent back siphonage & backpressure of hazardous materials into the portable water supply.

.3 Consists of a pressure differential relief valve located in a zone between two positive seating check valves.

.4 Include provision to admit air directly into the reduced pressure zone via a separate channel from the water discharge channel or via a separate vent directly into the supply pipe.

.5 Constructed using lead free cast copper silicon materials.

.6 Include two tightly closing shutoff valves before & after the assembly. Test cocks & a protective strainer upstream of the No. 1 shutoff valve.

.7 Conform to the requirements of ASSE Std 1013, AWWA Std C-511-92, CSA B64.4.

.3 Specialty backflow preventor with intermediate atmospheric vent:

.1 Watts Series 9D

.2 Forged brass body construction

.3 Durable tight seating rubber check valve assemblies

.4 Atmospheric Vacuum Breaker:

.1 Watts LF288A, LF289, LFN 388

.2 Body: lead free cast silicon copper alloy

.3 Disc: Silicone

.4 Spill-resistant diaphragm

.5 Temperature Range: 82C (180F)

.6 Max Working Pressure: 15PSI (8.6 Bar)

.5 Pressure Vacuum Breaker:

.1 Watts LF800M4QT

.2 Springs: Stainless steel

.3 Bonnet: Celcon

.4 Vent Disc: Silicone Rubber

.5 Body: Lead free cast copper silicon alloy

2.5 TRAP SEAL PRIMERS

.1 Individual Traps:

.1 Watts Drainage model MS-810

.2 Automatic cast brass body, renewable disc and seat rings, vacuum breaker and removable cover.

.2 Groups of Traps:

.1 PPP Inc. P1-500 (1-4 Floor Drains), or P2-500 (1-2 Floor Drains), all brass automatic pressure drop activated trap primer valve complete with supply tube and/or distribution units DU-U. Valve requires a 10 psi (70 kpa) pressure drop across the valve to activate. Constructed of 360 brass, EPDM E70 O-rings, Dow #7 Silicone, #60 stainless steel mesh screen, stainless steel adjustment screw.

2.6 CLEANOUTS

.1 Exterior Surfaced Areas:

.1 Watts Drainage model CO-200-RFC

.2 Round cast nickel bronze access frame and non-skid cover.

.2 Exterior Unsurfaced Areas:

.1 Watts Drainage model CO-300-MF

.2 Extra Heavy Duty type with epoxy coated cast iron body with two fixed

anchor flanges and round heavy duty ductile iron gasketed cover.

.3 Interior Finished Floor Areas:

.1 Watts Drainage model CO-200-R, CO-200-U

.2 Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round gasketed scored cover in service areas and round gasketed depressed cover to accept floor finish in finished floor areas.

.4 Interior Finished Wall Areas:

.1 Watts Drainage model WUCO

.2 Line type with lacquered cast iron body and round epoxy coated gasketed cover, and round stainless steel access cover secured with machine screw.

.5 Interior Unfinished Accessible Areas: Caulked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

.6 Line Cleanouts: lacquered cast iron Malcom type with cleanout ferrule, 1/2" (13mm) thick epoxy coated gasketed cover.

.7 Caulking for cleanouts: VOC content not to exceed 250g/L.

2.7 HYDRANTS

.1 Exterior Wall Hydrant, (H-1):

.1 Watts Drainage model HY-725

.2 ANSI/ASSE 1019; non-freeze, self-draining type with polished nickel bronze box and cover for recessed mounting, all bronze head, seat casting and internal working parts, 3/4" (20 mm) hose thread spout, key operated, integral vacuum breaker, galvanized wall casing and hydrant key.

.2 Interior Wall Hydrant, (H-2):

.1 Watts Drainage model HY-330

.2 ANSI/ASSE 1019; self-draining type with polished nickel bronze box and cover for recessed mounting, all bronze head, seat casting and internal working parts, 3/4" (20 mm) hose thread spout, key operated, integral vacuum breaker, galvanized wall casing and hydrant key.

2.8 WASHING MACHINE SHUTOFFS

.1 Watts WPWME-1

.2 Includes two WaterPEX® brass 1/4-turn shut off valves, one for hot and one for cold water, enclosed in a white protective enclosure with faceplate. The shut off levers are color coded red and blue to distinguish the hot from cold water line. The valve is designed to fit standard washing machine hoses. The white enclosure comes with brackets.

.3 Brass valve with plastic enclosure

.4 Threaded shank with nut

.5 Quarter turn valve

.6 Use with WaterPEX brass and Poly-alloy CrimpRing fittings

2.9 WATER HAMMER ARRESTORS

.1 WH-1: Provide Watts LF15M2 NPT solid hex lead free brass adapter end connection complete with copper body lead free construction, polypropylene piston, EPDM O-ring, Conforming to ASSE 1010, ANSI 112.26.1M, PDI WH201.

.2 WH-2: Provide properly sized Zurn Z17100 with nesting type bellows contained within casing having sufficient displacement volume to dissipate the calculated kinetic energy generated in the piping system. Both casing and bellows constructed of 18-8 stainless steel.

.3 WH-3: For shock associated with solenoid or other quick-closing valves serving heavy equipment such as laundry machines, dishwashers, etc. provide properly sized Zurn Z1712 Accumatrol complete with floating stainless steel spherical piston, surge chamber, valve and gauge assembly, bronze surge chamber, and viton valve seat. Maximum temperature – 500°F. Maximum pressure – 200 psi.

2.10 GREASE INTERCEPTOR

.1 Low Profile

.1 Zurn Z1171

.2 Dura-Coated interior and exterior fabricated steel low type grease interceptor as per drawing schedule with internal air relief bypass, bronze cleanout plug and trap seal with removable combination pressure equalizing/flow diffusing baffles.

.3 Provide gasketed secured cover complete with integral flow control.

.4 Provide all T304 fabricated stainless steel units with aluminum cover where indicated on drawings.

.5 Provide all T304 fabricated stainless steel units with stainless steel cover where indicated on drawings.

.6 Provide acid-resistant coated fabricated steel units where indicated on drawings.

.2 Large Capacity

.1 Zurn 1172

.2 Large capacity acid resistant coated interior and exterior fabricated steel grease interceptor as per drawing schedule with internal air relief bypass, bronze cleanout plug (which can be used as a sampling port) and visible

double-wall trap seal with removable combination pressure equalizing/flow diffusing baffles.

.3 Provide gasketed non-skid secured cover complete with removable lift handles and flow control fitting.

.4 Provide all T304 fabricated stainless steel units with stainless steel cover where indicated on drawings.

.5 Provide units with aluminum cover where indicated on drawings.

.6 Provide units with heavy-duty traffic covers rated at 4536 kg maximum safe live load where indicated on drawings.

.7 Provide anchor flanges as required for installation.

3 EXECUTION

3.1 GENERAL

.1 Install all products in accordance with the plumbing code and with manufacturer's instructions.

3.2 CLEANOUTS

.1 Provide cleanouts the same size as the pipe up to 4" (100mm) and not less than 4" (100mm) for larger pipes.

.2 Provide cleanouts at the end of mains and branches, at changes in direction, in long straight runs and at the base of all soil stacks and rainwater leaders and where required by code.

.3 Extend cleanouts to finished floor or wall surface.

.4 Encase exterior cleanouts in concrete flush with grade.

.5 Install floor cleanouts at elevation to accommodate finished floor.

.6 Cleanouts in floors with surface membranes shall be installed with a membrane clamp and anchoring flange.

.7 Lubricate threaded cleanout plugs with mixture of graphite and linseed oil.

.8 Ensure clearance at cleanout for rodding of drainage system.

3.3 FLOOR DRAINS

.1 Provide floor drains where indicated on architectural and plumbing floor plans.

.2 Inspect locations where floor drains are shown to determine that floor is sloped appropriately. Report concerns to Consultant prior to installation of drains.

.3 Coordinate installation with general trades.

.4 Trap and vent all floor drains in accordance with Plumbing Code.

.5 Provide trap seal priming for each floor drain trap.

.6 Floor drains in floors with surface membranes shall be installed with a membrane clamp and anchoring flange.

.7 Floor drains, traps and drainpipes installed in slabs on grade shall be embedded in concrete and made water-tight to prevent water seepage.

3.4 ROOF DRAINS

.1 Locate roof drains where indicated on roofing plans.

.2 Inspect locations where roof drains are shown to determine that roof is sloped appropriately. Report concerns to Consultant prior to installation of drains.

.3 Coordinate installation with other trades.

3.5 WALL HYDRANTS

.1 Locate wall hydrants where indicated.
.2 Coordinate installation with general trades.

3.6 WATER HAMMER ARRESTORS

.1 Install water hammer arrestors complete with an accessible isolation valve on hot and cold water supply piping to:

.1 plumbing fixtures and fixture groups,

.2 downstream of each backflow preventor,

.3 Owner's equipment and appliances with flush valves, solenoid valves or other quick closing valves

.4 wherever necessary to prevent water hammer.

3.7 TRAP SEAL PRIMERS

.1 Condensate drains from cooling units may not be used to prime traps.

.2 Where floor drains are being replaced having new trap seal primers, protect existing priming lines during the floor drain replacement process. Connect existing priming lines to new trap seal primers.

3.8 INTERCEPTORS

.1 Install interceptors so as to be accessible for cleaning and all other maintenance and repair which may be required.

.2 Make piping connections. Vent in accordance with Plumbing Code.

.3 Fill with appropriate media as required and turn over spare media to Owner.

3.9 BACKFLOW PREVENTION

.1 Backflow prevention includes backflow preventors, anti-siphon devices and vacuum breakers.

.2 Install approved potable water protection devices in readily accessible areas to facilitate inspection, field testing and maintenance on water supply lines where contamination of domestic water may occur:

- .1 Boiler feed water lines,
- .2 Housekeeping faucets,
- .3 Fire sprinkler systems,
- .4 Premise isolation,
- .5 Irrigation systems,
- .6 Flush valves,
- .7 Interior and exterior wall hydrants (hose bibbs).
- .8 Where required by codes, regulations and/or standards.

.3 The following minimum clearances shall be provided (manufacturer's recommendations shall be used if greater):

- .1 Install double check valve (DCVA/DCVAF, reduced pressure (RP/RPF assemblies and single check valve assemblies with a centerline height of between 750 mm and 1500 mm above the floor. Provide a fixed platform for installations with a greater height.
- .2 Install RP/RPF devices with a 300 mm minimum clearance between the bottom of the relief valve and the floor.
- .3 Install PVB, DCVA, DCVAF, SCVAF, RP, and RPF devices with a minimum of 300 mm clearance above the assembly.
- .4 Maintain minimum of 750 mm of clear space in front of PVB, DCVA, DCVAF, SCVAF, RP and RPF assemblies.
- .5 Maintain a minimum of 20 mm clear space from the back side of PVB, DCVA, DCVAF, SCVAF, RP and RPF devices to the nearest wall or obstruction. Note: This clearance must be increased for devices with side-mounted test-cocks or relief valves.

.4 Pipe relief or drain from backflow prevention device to nearest drain.

.5 Install a strainer upstream of each backflow preventor.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 20 01 01.

1.2 SECTION INCLUDES

.1 Domestic Hot Water Recirculation Pumps.

.2 Sump Pumps.

1.3 REFERENCE STANDARDS

.1 American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE)

.1 Standard 90.1-2013—Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings.

.2 CSA Group (CSA)

.1 CSA 22.2 – General requirements – Canadian Electrical Code

1.4 SHOP DRAWING UBMITTALS

.1 Product Data:

.1 Indicate pump type, capacity, power requirements.

.2 Controls.

.3 Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.

.4 Provide electrical characteristics and connection requirements.

.2 Shop Drawings:

.1 Indicate pump dimensions, sump or tank dimensions, size of tappings.

.2 Wiring diagrams.

1.5 CLOSEOUT SUBMITTALS

.1 Project Record Documents: Record actual locations of components.

.2 Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

.3 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

.2 Provide pumps with manufacturer's name, model number, and rating/capacity identified.

.3 Ensure products and installation of specified products are to recommendations and requirements of the following organizations:

.1 National Sanitation Foundation (NSF).

.2 American Society of Mechanical Engineers (ASME).

.3 Canadian Standards Association (CSA)

.4 National Electrical Manufacturers' Association (NEMA).

.5 Underwriters Laboratories of Canada (ULC).

.4 Ensure pumps operate at specified system fluid temperatures without vapour binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

.5 Provide pumps meeting the energy efficiency requirements of ASHRAE 90.1 where applicable.

1.7 REGULATORY REQUIREMENTS

.1 Products Requiring Electrical Connection: Listed and classified by CSA, ULC, cUL or Special Inspection as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in a dry location, and in accordance with manufacturers’ recommendations in clean, dry, well-ventilated area.

.2 Store and protect fire protection products from nicks, scratches, blemishes, theft, vandalism and vermin.

.4 Replace defective or damaged materials with new.

.5 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal

1.9 WARRANTY

.1 Provide five year manufacturer warranty for pumps.

1.10 EXTRA MATERIALS

.1 Provide two pump seals.

2 PRODUCTS

2.1 IN-LINE CIRCULATORS

.1 Manufacturers

.1 Bell & Gossett

.2 SA Armstrong

.3 Taco

.2 Type: High performance, variable speed, wet-rotor circulator with high efficiency ECM permanent magnet motor.

.3 Casing: Lead-free bronze or stainless steel.

.4 Connections: Flanged.

.5 Impeller: Composite, bronze or stainless steel.

.6 Bearings: Ceramic

.7 Shaft: Ceramic, alloy or stainless steel.

.8 O-ring & gaskets: EPDM

.9 Max Working Pressure: 150 PSI (10.3 Bar)

.10 Min Operating Temperature: 14°F (-10° C)

.11 Max Operating Temperature: 225F (107 C)

.12 Certified to NSF 61 and 372.

.13 ETL or UL certified to CAN/CSA C22.2.

2.2 SUBMERSIBLE SUMP PUMP

.1 Manufacturers

.1 Zoeller

.2 Liberty Pumps

.2 Pump Controls

.1 NEMA 1 indoor duplex control panel with four float switches including a high water alarm

.3 Pump construction:

.1 Casing: class 25 cast iron.

.2 Motor housing: oil-filled to dissipate heat. Air-filled motors shall not be considered equal since they do not properly dissipate heat from the motor.

.3 Mating parts: machined and sealed with a Buna-N O-ring.

.4 Fasteners exposed to the liquid: stainless steel.

.5 Motor protected on the top side with sealed cord entry plate with molded pins to conduct electricity, eliminating the ability of water to enter internally through the cord.

.6 Motor protected on the lower side with a unitized ceramic carbon seal with stainless steel housings and spring.

.7 Upper and lower bearing capable of handling all radial and thrust loads.

.8 Furnished with stainless steel handle.

.4 Power Cord

.1 Supplied with length of multiconductor power cord as per Electrical Data table.

.2 Cord type SJTW (1-phase) or SEOOW (3-phase), capable of continued exposure to the pumped liquid, sized for the rated full load amps of the pump in accordance with the National Electric Code.

.3 Conducts electricity to the motor by means of a watertight compression fitting cord plate assembly, with molded pins to conduct electricity. This will eliminate the ability of water to enter internally through the cord by means of a damaged or wicking cord.

.5 Motors

.1 Single-phase motors shall be oil-filled, permanent split capacitor, class B insulated NEMA B design, rated for continuous duty. Three-phase motors shall be oil-filled, class B insulated NEMA B design, rated for continuous duty.

.2 At maximum load, the winding temperature shall not exceed 130° C unsubmerged.

.3 Single-phase pump motors shall have an integral thermal overload switch in the windings for protecting the motor.

.4 Three-phase motors shall be used with an appropriate controller with integral overload protection. The capacitor circuit shall be mounted internally in the pump on single-phase units.

.6 Bearings And Shaft

.1 Upper and lower ball bearings shall be required. The bearings shall be a single ball/race type bearing. Both bearings shall be permanently

lubricated by the oil that fills the motor housing. The motor shaft shall be made of 300 or 400 series stainless steel and have a minimum diameter of 0.625".

.7 Seals

.1 Unitized carbon ceramic seal with stainless steel housings and spring equal to Crane Type 6A. The motor plate / housing interface shall be sealed with a Buna-N O-ring.

.8 Impeller

.1 Class 25 cast iron with pump out vanes on the back shroud to keep debris away from the seal area. It shall be threaded to the motor shaft.

.9 Controls

.1 Single-phase units can be supplied with CSA and UL approved automatic wide-angle tilt float switches. The switches shall be equipped with a piggyback style plug that allows the pump to be operated manually without the removal of the pump if a switch becomes inoperable. Manual pumps are operable by means of a pump control panel.

.10 Paint

.1 Exterior of the casting protected with powder coat paint.

.11 Support

.1 Cast iron support legs enabling it to be a freestanding unit. The legs will be high enough to allow 2" solids to enter the volute.

.12 Factory Assembled Tank Systems With Guide Rail And Quick Disconnect Discharge

.1 Factory mounted guide rail system with pump suspended by means of bolt on quick disconnect that is sealed by means of nitrile grommets or O-rings. The discharge piping shall be Schedule 80 PVC and furnished with a PVC shut-off ball valve. The tank shall be wound fiberglass or roto-molded plastic. An inlet hub shall be provided with the fiberglass systems.

.2 Options:

.1 Stainless steel guide rail

.2 Steel cover

.3 Duplex System with indoor panel and alarm

.13 Factory Testing

.1 The pump shall have a ground continuity check and the motor chamber shall be hi-potted to test for electrical integrity, moisture content and insulation defects.

.2 The motor and volute housing shall be pressurized and an air leak decay

test performed to ensure integrity of the motor housing.

.3 The pump shall be monitored for run voltage and current, and checked for noise or other malfunction.

.14 Quality Control: Manufactured in an ISO 9001 certified facility.

.15 Warranty: Standard limited warranty - 3 years.

.16 Approvals: UL Listed, CSA

3 EXECUTION

3.1 PREPARATION

.1 Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

.1 Install according to manufacturer's instructions.

.2 Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.

.3 Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings.

.4 Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.

.5 Provide air cock and drain connection on horizontal pump casings.

.6 Provide drains for bases and seals, piped to and discharging into floor drains.

.7 Check, align, and certify alignment of base mounted pumps prior to start-up.

.8 Lubricate pumps before start-up.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 22 01 01.

1.2 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME)

- .1 ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- .3 ASME B16.23, Cast Copper Alloy Solder Joint Drainage Fittings - DWV.
- .4 ASME B16.26, Copper Alloy Bronze Fittings for Flared Copper Tubes.
- .5 ASME B16.29, Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
- .6 ASME B16.32, Cast Copper Alloy Solder Joint Fittings for Solvent Drainage Systems.

.2 ASTM International (ASTM)

- .1 ASTM B32, Standard Specification for Solder Metal.
- .2 ASTM A74, Standard Specification for Cast Iron Soil Pipe and Fittings.
- .3 ASTM B306, Standard Specification for Copper Drainage Tube (DWV).
- .4 ASTM C564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

.3 Cast Iron Soil Pipe Institute (CISPI)

- .1 CISPI 301, Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping.
- .2 CISPI 310, Couplings for use in connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.

.4 CSA Group (CSA)

- .1 CSA B67, Lead Service Pipe, Waste Pipe, Traps, Bends and Accessories.
- .2 CAN/CSA-B70, Cast Iron Soil Pipe, Fittings and Means of Joining.

.3 CAN/CSA-B125.3, Plumbing Fittings.

.5 Green Seal Environmental Standards (GSES)

.1 Standard GS-36, Commercial Adhesives.

.6 National Research Council Canada (NRC)

.1 National Plumbing Code of Canada (NPC).

1.3 SHOP DRAWING 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 adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in a dry location, and in accordance with manufacturers’ recommendations in clean, dry, well-ventilated area.

.2 Store and protect fire protection products from nicks, scratches, blemishes, theft, vandalism and vermin.

.4 Replace defective or damaged materials with new.

.5 Packaging Waste Management: remove for reuse and return by manufacturer of 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 COPPER TUBE AND FITTINGS

.1 Above ground sanitary, storm and vent Type DWV to: ASTM B306.

.1 Fittings.

.1 Cast brass: to CAN/CSA-B125.3.

.2 Wrought copper: to CAN/CSA-B125.3.

.2 Solder: tin-lead, 50:50, type 50B, to ASTM B32.

2.2 CAST IRON PIPING AND FITTINGS

.1 Buried sanitary, storm and vent minimum NPS 3:

.1 CAN/CSA-B70 and ASTM A74 extra heavy weight with one layer of protective coating of epoxy on the pipe interior and exterior.

.1 Joints: Hub and spigot: CISPI HSN compression type with ASTM C564, neoprene gasket system or lead and oakum.

.2 Fittings: Cast iron

.2 CISPI 301 hub-less

.1 Joints: CISPI 310, neoprene gasket and stainless steel clamp and shield assemblies.

.2 Fittings: Cast iron

.2 Above ground sanitary and vent:

.1 CAN/CSA-B70 and ASTM A74 service weight.

.1 Joints: ASTM C564, neoprene gasket system.

.2 Fittings: Cast iron

.2 CISPI 301 hub-less, service weight.

.1 Mechanical joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.

.2 Fittings: Cast Iron.

.3 Above ground storm:

.1 to CAN/CSA-B70 and ASTM A74 extra heavy weight.

.1 Joints: ASTM C564, neoprene gasket system or lead and oakum.

.2 Fittings: Cast iron

.2 CISPI 301, hub-less, service weight

.1 Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.

.2 Fittings: Cast Iron.

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 Ontario Plumbing Code and local authority having jurisdiction.

3.3 UNDERGROUND SEWER LINES

.1 Provide qualified personnel to properly layout and establish lines and grades necessary for construction. Verify location and inverts of existing services before sewer work is started to ensure that connection of new sewers to existing can be made. Construct and maintain adequate batter boards, alignment markers and secondary benchmarks as may be required for proper execution of work.

.2 Ensure batter boards or sight lines are set not more than 25 ft. (7.5 m) apart. Ensure a minimum of three (3) batter boards are in place at all times during laying operation.

.3 Notify Consultant of layout work to be carried out, Consultant shall have right to check Contractor's layout at any time, but checking layout or failure to do so on part of Consultant in no way relieves Contractor of full responsibility for construction to exact alignment and grade.

.4 Verify existing invert elevations before setting out drainage work.

.5 Build to exact lines and grades as shown on drawings. No deviation from these lines and grades will be permitted unless approved in writing by Consultant.

3.4 EXCAVATING AND BACKFILLING

.1 Be responsible for excavation and backfilling necessary for installation of underground work under this Division.

.2 Excavate with suitable machinery or by hand as may be necessary and as follows:

.1 Excavate to the depth and dimensions shown on drawings.

.2 Keep excavation free of water by bailing, pumping or a system of drainage as required.

.3 Cut and trim banks of excavation evenly, as nearly vertical as possible, and shore if required to prevent caving-in.

.4 Keep bottom of excavation clean and clear of loose material. Slope or grade as required.

.5 Provide shoring in accordance with The Occupational Health and Safety Act and Regulations for Construction Projects.

.6 Notify Consultant immediately in case of encountering any unstable ground, unsuitable for bearing of pipes. Consultant will decide the method of installation of pipes in unstable ground.

.7 Inform Consultant immediately if the excavation reveals seepage zones, springs or other unexpected sub-surface conditions which may necessitate revisions to drainage or water supply systems.

.3 Obtain Consultant's approval prior to commencement of backfilling of trenches. Backfill the trenches carefully to prevent injury to the work and subsequent settlement and execute backfilling generally as follows:

.1 Provide minimum 6" (150 mm) fine gravel or coarse sand bedding (Class B) or as indicated for the bottom of trenches.

.2 Backfill above pipe bedding with granular material specified, hand tamp in layers of 6" (150 mm) thickness. Extend backfill 12" (300 mm) above pipe.

.3 Backfill and consolidate remainder of trench depth below paved or graveled areas with granular Class "B" aggregate in 6" (150 mm) layers to an elevation to allow for thickness of Class "A" aggregate and asphalt pavement.

.4 Backfill and consolidate reminder of trench depth below sodded or seeded areas with specified granular material or material obtained from site excavation where approved by Consultant, in 9" (225 mm) layers to an elevation 6" (150 mm) below of proposed grades in sodded/seeded areas.

.5 Compact each layer thoroughly at optimum moisture content with approved hand or mechanical tampers to a density equal to;

.1 95% of Maximum Standard Proctor Density

.1 Behind foundation and retaining walls on grades

.2 Below sodded or seeded areas

.2 100% of Maximum Standard Proctor Density

.1 Below slabs on grade within building areas up to the underside of the crushed stone underlay

.2 Below paved or graveled areas

.6 Do not puddle or flood with water for consolidating backfill. Add Water during the compaction to optimum moisture content of backfilling material.

3.5 TESTING

.1 Pressure test buried systems before backfilling.

.2 Hydraulically test to verify grades and freedom from obstructions.

3.6 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 that 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 that fixtures are properly anchored, connected to system and effectively vented.

.5 Affix applicable label (storm, sanitary, vent, pump discharge etc.) c/w directional arrows every floor or 4.5 m (whichever is less).

3.7 CLEANING

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

.2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 22 01 01.

1.2 REFERENCE STANDARDS

.1 ASTM International (ASTM)

.1 ASTM D2241, Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

.2 ASTM D2235, Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.

.3 ASTM D2564, Standard Specification for Solvent Cements for Poly (Vinyl-Chloride) (PVC) Plastic Piping Systems.

.4 ASTM D2661, Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.

.5 ASTM D2665, Standard Specification for Poly(Vinyl Chloride) (PVC) Drain, Waste, and Vent Pipe and Fittings.

.6 ASTM D2680, Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping.

.7 ASTM D2855, Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets

.8 ASTM D3034, Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

.9 ASTM F477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

.10 ASTM F628, Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe With a Cellular Core.

.11 ASTM F1673, Standard Specification for Polyvinylidene Fluoride (PVDF) Corrosive Waste Drainage Systems

.2 CSA Group (CSA)

.1 CAN/CSA-Series B1800, Thermoplastic Nonpressure Pipe Compendium - B1800 Series.

.3 Green Seal Environmental Standards (GSES)

.1 Standard GS-36, Commercial Adhesives.

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

.1 Safety Data Sheets (SDS).

.5 National Research Council Canada (NRC)

.1 National Plumbing Code of Canada (NPC).

.6 Standards Council of Canada (CAN/ULC)

.1 CAN/ULC-S102.2, Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies.

1.3 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 piping and adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Provide WHMIS SDS - Safety Data Sheets in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.4 DELIVERY, STORAGE AND HANDLING

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

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Store at temperatures and conditions recommended by manufacturer.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 PIPING AND FITTINGS

.1 For buried DWV piping to:

.1 CAN/CSA B1800.

.2 For above ground DWV piping to:

.1 CAN/CSA B1800 and CAN/ULC-S102.2.

.2 Do not use in vertical mechanical shafts or service spaces.

.3 IPEX System 15 or XFR as per manufacturer specifications.

2.2 JOINTS (STANDARD DWV).

.1 Solvent weld for PVC: to ASTM D2564.

.2 Solvent weld for ABS: to ASTM D2235.

.3 Elastomeric gaskets: to ASTM F477.

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 Ontario Plumbing Code and local authority having jurisdiction.

3.3 UNDERGROUND SEWER LINES

.1 Provide qualified personnel to properly layout and establish lines and grades necessary for construction. Verify location and inverts of existing services before sewer work is started to ensure that connection of new sewers to existing can be made. Construct and maintain adequate batter boards, alignment markers and secondary benchmarks as may be required for proper execution of work.

.2 Ensure batter boards or sight lines are set not more than 25 ft. (7.5 m) apart. Ensure a minimum of three (3) batter boards are in place at all times during laying operation.

.3 Notify Consultant of layout work to be carried out, Consultant shall have right to check Contractor's layout at any time, but checking layout or failure to do so on part of Consultant in no way relieves Contractor of full responsibility for construction to exact alignment and grade.

.4 Verify existing invert elevations before setting out drainage work.

.5 Build to exact lines and grades as shown on drawings. No deviation from these lines and grades will be permitted unless approved in writing by Consultant.

.6 Completely surround plastic piping by at least 4" (100 mm) non-cohesive ballast material of which at least 50% will pass a 1/4" (6.35 mm) sieve and 100% will pass a 1/2" (12.7 mm) sieve, and that is sufficiently consolidated so that the intended earth loading will not produce further compaction.

3.4 EXCAVATING AND BACKFILLING

.1 Be responsible for excavation and backfilling necessary for installation of underground work under this Division.

.2 Excavate with suitable machinery or by hand as may be necessary and as follows:

.1 Excavate to the depth and dimensions shown on drawings.

.2 Keep excavation free of water by bailing, pumping or a system of drainage as required.

.3 Cut and trim banks of excavation evenly, as nearly vertical as possible, and shore if required to prevent caving-in.

.4 Keep bottom of excavation clean and clear of loose material. Slope or grade as required.

.5 Provide shoring in accordance with The Occupational Health and Safety Act and Regulations for Construction Projects.

.6 Notify Consultant immediately in case of encountering any unstable ground, unsuitable for bearing of pipes. Consultant will decide the method of installation of pipes in unstable ground.

.7 Inform Consultant immediately if the excavation reveals seepage zones, springs or other unexpected sub-surface conditions which may necessitate revisions to drainage or water supply systems.

.3 Obtain Consultant's approval prior to commencement of backfilling of trenches. Backfill the trenches carefully to prevent injury to the work and subsequent settlement and execute backfilling generally as follows:

.1 Provide minimum 6" (150 mm) fine gravel or coarse sand bedding (Class B) or as indicated for the bottom of trenches.

.2 Backfill above pipe bedding with granular material specified, hand tamp in layers of 6" (150 mm) thickness. Extend backfill 12" (300 mm) above pipe.

.3 Backfill and consolidate remainder of trench depth below paved or graveled areas with granular Class "B" aggregate in 6" (150 mm) layers to an elevation to allow for thickness of Class "A" aggregate and asphalt pavement.

.4 Backfill and consolidate reminder of trench depth below sodded or seeded areas with specified granular material or material obtained from site excavation where approved by Consultant, in 9" (225 mm) layers to an elevation 6" (150 mm) below of proposed grades in sodded/seeded areas.

.5 Compact each layer thoroughly at optimum moisture content with approved hand or mechanical tampers to a density equal to;

.1 95% of Maximum Standard Proctor Density

.1 Behind foundation and retaining walls on grades

.2 Below sodded or seeded areas

.2 100% of Maximum Standard Proctor Density

.1 Below slabs on grade within building areas up to the underside of the crushed stone underlay

.2 Below paved or graveled areas

.6 Do not puddle or flood with water for consolidating backfill. Add Water during the compaction to optimum moisture content of backfilling material.

3.5 ACID WASTE SANITARY PIPING

.1 Install system free of stress and in proper alignment.

.2 Ensure horizontal supports provide a wide bearing area and are free of burrs and sharp edges.

.3 Ensure vertical piping has riser clamps on each floor.

.4 Testing with compressed air including air booster over water is prohibited.

3.6 TESTING

.1 Pressure test buried systems before backfilling.

.2 Hydraulically test to verify grades and freedom from obstructions.

3.7 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).

3.8 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

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Division 22 01 01.

.2 Plumbing systems arrangement as shown on the Contract Drawings is diagrammatic. Refer to latest Architectural Drawings for final layout of walls, partitions, and building areas.

.3 Check and verify dimensions and conditions on the Site and ensure that the Work can be performed as indicated. Report all discrepancies to the Consultant before proceeding with the Work.

.4 Prepare complete plumbing systems layout drawings, arranging piping runs in proper relation to other equipment such as light fixtures and ducts to ensure clear ceiling heights indicated on the Drawings. Maintain maximum headroom in areas with no ceilings.

.5 Take into consideration architectural, structural, mechanical and electrical layouts of the building. Arrange piping mains and branches to not interfere with systems and equipment.

1.2 SECTION INCLUDES

.1 Pipe, pipe fittings, valves, and connections for piping systems.

.1 Domestic (Potable) Water.

.2 Disinfection of potable water distribution system

.3 Testing and reporting results

1.3 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

.2 ASME B16.5, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24, Metric/Inch Standard.

.3 ASME B16.10, Face-to-Face and End-to-End Dimensions of Valves.

.4 ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.

.5 ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

.6 ASME B16.23, Cast Copper Alloy Solder Joint Drainage Fittings - DWV.

.7 ASME B16.26 - Copper Alloy Bronze Fittings for Flared Copper Tubes.

.8 ASME B16.32 - Cast Copper Alloy Solder Joint Fittings for Solvent Drainage Systems.

.2 ASTM International (ASTM)

.1 ASTM B32, Solder Metal.

.2 ASTM B42, Standard Specification for Seamless Copper Pipe, Standard Sizes.

.3 ASTM B61, Standard Specification for Steam or Valve Bronze Castings.

.4 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.

.5 ASTM B68, Seamless Copper Tube, Bright Annealed.

.6 ASTM B75, Seamless Copper Tube.

.7 ASTM B88, Seamless Copper Water Tube.

.8 ASTM A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

.9 ASTM B283, Standard Specification for Copper and Copper-Alloy Die Forgings (Hot-Pressed).

.10 ASTM B251, General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.

.11 ASTM B302, Threadless Copper Pipe, Standard Sizes.

.12 ASTM C1053, Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications.

.13 ASTM D2239, Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.

.14 ASTM D2447, Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter.

.15 ASTM E814, Fire Tests of Through-Penetration Fire Stops.

.16 ASTM F708, Design and Installation of Rigid Pipe Hangers.

.3 American Water Works Association (AWWA)

.1 AWWA C110, Ductile - Iron and Gray - Iron Fittings, 3" - 48" (76 mm - 1219 mm), for Water.

.2 AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.3 AWWA C151, Ductile-Iron Pipe, Centrifugally Cast, for Water.

.4 AWWA C651, Disinfecting Water Mains.

.5 AWWA C900, Polyvinyl Chloride (PVC) Pressure Pipe (and Fabricated Fittings), 4" - 12" (100 mm - 300 mm), for Water Distribution.

.6 AWWA C901, Polyethylene (PE) Pressure Pipe and Tubing, 1/2" - 3" (13 mm - 76 mm) for Water Service.

.7 AWWA C902, Polybutylene (PB) Pressure Pipe and Tubing, 1/2" - 3" (13 mm - 76 mm) for Water.

.8 AWWA C905, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14" - 48" (350 mm - 1200mm).

.4 American National Standards Institute (ANSI)

.1 MSS SP-58, Pipe Hangers and Supports - Materials, Design and Manufacturer.

.2 MSS SP-69, Pipe Hangers and Supports - Selection and Application.

.3 MSS SP-80, Bronze Gate, Globe, Angle, and Check Valves

.4 MSS SP-89, Pipe Hangers and Supports - Fabrication and Installation Practices.

.5 MSS SP-110, Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.4 SHOP DRAWING SUBMITTALS

.1 Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.

1.5 CLOSEOUT SUBMITTALS

.1 Project Record Documents: Record actual locations of valves.

1.6 QUALITY ASSURANCE

.1 Perform Work to Province of Ontario standards. Maintain one copy on site.

.2 Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.7 REGULATORY REQUIREMENTS

.1 Perform Work to Province of Ontario plumbing code.

.2 Conform to applicable code for installation of backflow prevention devices.

.3 Provide certificate of compliance from authority having jurisdiction indicating approval of installation of backflow prevention devices.

1.8 DELIVERY, STORAGE, AND PROTECTION

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in a dry location, and in accordance with manufacturers' recommendations in clean, dry, well-ventilated area.

.2 Store and protect fire protection products from nicks, scratches, blemishes, theft, vandalism and vermin.

.4 Replace defective or damaged materials with new.

.5 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal

.6 Provide temporary protective coating on cast iron and steel valves.

.7 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

.8 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.9 ENVIRONMENTAL REQUIREMENTS

.1 Do not install underground piping when bedding is wet or frozen.

2 PRODUCTS

2.1 WATER PIPING, BURIED WITHIN 1.5m OF BUILDING

.1 Copper Tubing: ASTM B42, hard drawn.

.1 Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.

.2 Joints: AWS A5.8, BCuP silver braze.

.2 Copper Tubing: ASTM B42, annealed.

.1 Fittings: ASME B16.26, cast bronze.

.2 Joints: Flared.

.3 Ductile Iron Pipe: AWWA C151.

.1 Fittings: Ductile iron, standard thickness.

.2 Lining: cement

.3 Joints: AWWA C111, rubber gasket with 3/4" (19 mm) diameter rods.

2.2 WATER PIPING, ABOVE GRADE

.1 Copper Tubing: ASTM B88M, Type L, hard drawn.

.1 Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought

copper and bronze.

.2 Joints: ASTM B32, solder, Grade 95TA.

.2 Ductile Iron Pipe: AWWA C151.

.1 Fittings: Ductile iron, standard thickness.

.2 Lining: cement

.3 Joints: AWWA C111, rubber gasket with 3/4" (19 mm) diameter rods.

2.3 FLANGES, UNIONS, AND COUPLINGS

.1 Pipe Size 3-1/4" (80 mm) and Under:

.1 Ferrous pipe: Class 150 malleable iron threaded unions.

.2 Copper tube and pipe: Class 150 bronze unions with soldered joints.

.2 Pipe Size Over 1" (25 mm):

.1 Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.

.2 Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

.3 Grooved and Shouldered Pipe End Couplings:

.1 Housing: Malleable iron clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; steel bolts, nuts, and washers; galvanized for galvanized pipe.

.2 Sealing gasket: “C" shape composition sealing gasket.

.4 Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.4 VALVES - GENERAL

.1 Conform to requirements of ANSI, ASTM, ASME, and applicable MSS standards.

.2 Provide valves of the same manufacturer where possible.

.3 Manufacturer's name and pressure rating clearly marked on body to MSS-SP-25.

.4 Valid CRN (Canadian Registration Number) issued by Province of Ontario required for each valve.

.5 Materials:

.1	Bronze:	ASTM B62 or B61 as applicable
.2	Brass:	ASTM B283 C3770
.3	Cast Iron:	ASTM A126 Class B

.6 End Connections:

.1 Flanged ends: ANSI B16.1 (Class 125), ANSI B16.5

.2 Face-to-face dimensions: ANSI B16.10

.7 Design and Testing:

.1 Bronze Gate & Check valves: MSS-SP-80

.2 Ball Valves: MSS-SP-110

.8 First named product as indicated in paragraphs below; other acceptable manufacturers, subject to equivalent products listed on spread sheet attached.

2.5 ISOLATION VALVES

.1 Up To and including 2" (50mm) - Ball type

.1 Manufacturer: Watts, MA Stewart

.2 Construction: MSS SP-110, Class 150, 600 psi (4140 kPa) CWP, forged brass, two piece body, stainless steel ball and stem, full port, virgin PTFE seats and stem packing, blow-out proof stem, lever handle with balancing stops, stem extensions for insulated piping, solder ends.

2.6 CHECK VALVES

.1 Up to and Including 3" (75 mm):

.1 Manufacturers: Watts, MA Stewart

.2 Construction: MSS SP-80, 860 kPa (125psig) 200 WOG, bronze body to ASTM B62, bronze trim, solder ends

2.7 DRAIN VALVES

.1 Up to 150 psig - Ball type:

.1 Manufacturers: Watts, MA Stewart

.2 Construction: 150 psig (1034 kPa), 600 WOG, brass body to ASTM C37700, two piece body, full port, PTFE seats and stem packing or double "O" ring, blow-out proof stem, Chrome Plated ball, lever handle with cap and chain, (3/4") 20 mm hose connection.

2.8 CIRCUIT BALANCING VALVES

.1 Up to 2” (50mm):

.2 Manufacturer: SA Armstrong, MA Stewart

.3 Furnish and install, as shown on plans and in accordance to manufacturer’s installation instructions, Armstrong Circuit Balancing Valves. Valves are to be of the ‘Y’ pattern, equal percentage globe-style and provide three functions:

.1 Precise flow measurement

.2 Precision flow balancing

.3 Positive drip-tight shut-off

.4 Valve shall provide multi-turn, 360° adjustment with micrometer type indicators located on the valve handwheel. Valves shall have a minimum of five full 360° handwheel turns. 90° 'circuit-setter' style ball valves are not acceptable. Valve handle shall have hidden memory feature, which will provide a means for locking the valve position after the system is balanced.

.5 Valves shall be furnished with precision machined venturi built into the valve body to provide highly accurate flow measurement and flow balancing. The venturi shall have two, ¼" threaded brass metering ports with check valves and gasketed caps located on the inlet side of the valve. Valves shall be furnished with flow smoothing fins downstream of the valve seat and integral to the forged valve body to make the flow more laminar. The valve body, stem and plug shall be brass. The handwheel shall be high-strength resin.

2.9 DISINFECTION CHEMICALS

.1 Chemicals: AWWA B300, Hypochlorite,

3 EXECUTION

3.1 EXAMINATION

.1 Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

.1 Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

.2 Remove scale and dirt, inside and outside, before assembly.

.3 Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

.1 Install to manufacturer's instructions.

.2 Provide non-conducting dielectric connections wherever jointing dissimilar metals.

.3 Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

.4 Install piping to maintain headroom, conserve space, and not interfere with use of space.

.5 Group piping whenever practical at common elevations.

.6 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

.7 Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

.8 Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with general trades.

.9 Establish elevations of buried piping outside the building to ensure not less than 5'6" (1.6 m) of cover.

.10 Install vent piping penetrating roofed areas to maintain integrity of roof assembly; coordinate with roof and waterproofing specification.

.11 Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer (maximum VOC content of 80 g/L) to welding.

.12 Provide support for utility meters to requirements of utility companies.

.13 Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting where required. Coordinate with general trades.

.14 Excavate and backfill as required for work of this Section.

.15 Install bell and spigot pipe with bell end upstream.

.16 Install valves with stems upright or horizontal, not inverted.

.17 Pipe vents from gas pressure reducing valves to outdoors and terminate in weatherproof hood.

.18 Sleeve pipes passing through partitions, walls and floors.

.19 Inserts:

.1 Provide inserts for placement in concrete formwork.

.2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

.3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4" (100 mm).

.4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

.5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

.20 Pipe Hangers and Supports:

.1 Install to OBC (Plumbing Code)

.2 Support horizontal piping as scheduled.

.3 Install hangers to provide minimum 1/2" (15 mm) space between finished covering and adjacent work.

.4 Place hangers within 12" (300 mm) of each horizontal elbow.

.5 Use hangers with 1-1/2" (40 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

.6 Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.

.7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

.8 Provide copper plated hangers and supports for copper piping.

.9 Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

.10 Provide hangers adjacent to motor driven equipment with vibration isolation.

.11 Support cast iron drainage piping at every joint.

3.4 UNDERGROUND WATER MAINS - 100mm AND LARGER DIAMETER

.1 Install pipes to bear throughout their full length. Do not support piping by the bell ends only or by blocks.

.2 Anchoring of Mains: Provide pipe clamps and tie-rods, thrust blocks, locked mechanical or push-on mechanical joints utilizing set screw retainer glands or other approved methods or devices.

.3 Sizing clamps, rods, bolts & washers.

.1 Clamps: 1/2" x 2" (12.7 x 50 mm) for pipe 6" (150 mm) and smaller

.2 Rods: minimum size of 5/8" (16 mm)

.3 Clamp bolts: minimum 5/8" (16 mm)

.4 Washers: minimum 5/8" x 3" (16 x 75 mm) cast iron or steel, round or square.

.4 Sizing of anchor straps for tees: minimum 5/8" (16 mm) thick by 2-1/2" (62 mm) wide.

.5 Sizing of plug strap for bell end pipe: minimum 3/4" (20 mm) thick by 2-1/2" (62 mm) wide.

.6 Clean all bolted joint accessories thoroughly and coat with asphalt or other corrosion retarding material after installation.

.7 Thrust Blocks:

.1 Provide at each change in direction of pipeline and at all tees, plugs, caps, and bends.

.2 Use a concrete mix not leaner than one part cement, two and one-half parts sand, and five parts stone. Place backing between undisturbed earth and fitting to be anchored.

.3 In general, place backing so that the joints will be accessible for inspection and repair.

.8 Area of Bearing Face of Concrete Thrust Blocks

PIPE SIZE	1/4 BEND		1/8 BEND		TEES, PLUGS, CAPS AND HYDRANTS	
	SQ. FT.	SQ. M	SQ. FT.	SQ. M	SQ. FT.	SQ. M
4”	2	0.19	2	0.19	2	0.19
6”	5	0.46	3	0.28	4	0.37
8”	8	0.74	5	0.46	6	0.56
10”	13	1.21	7	0.65	9	0.84
12”	18	1.67	10	0.93	13	1.21

.9 The above bearing face areas are based on undisturbed soil. Use the following multiplying factors for the following ground conditions:

Soft Clay 4.0 Sand 2.0

Sand & Gravel 1.3 Shale 0.4

.10 Do hydrostatic testing prior to backfilling over joints.

.11 Backfilling: backfill as indicated. In addition, puddle where possible to prevent settlement or lateral movement.

.12 Install ductile iron pipe and fittings in accordance with AWWA C600, Standard for installation of Ductile Iron and Cast-Iron Watermains. Provide minimum frost cover for watermain 5'-6" (1600 mm).

.13 Stretch copper tube installed underground until it is straight and every bend made in it thereafter shall be made with tools designed for the purpose of bending with constant radius. Provide minimum frost cover for watermain of 5'-6" (1600 mm).

.14 Water main will be brought into building to a point 12" (310 mm) above floor and capped with a blank flange by trades doing outside services.

3.5 APPLICATION

.1 Use grooved mechanical couplings and fasteners only in accessible locations.

.2 Install unions downstream of valves and at equipment or apparatus connections.

.3 Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

.4 Install gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.

.5 Install globe valves for throttling, bypass, or manual flow control services.

.6 Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.

.7 Provide plug valves in natural gas systems for shut-off service.

.8 Provide flow controls in water recirculating systems where indicated.

3.6 ERECTION TOLERANCES

.1 Establish invert elevations, slopes for drainage to 2 percent minimum. Maintain gradients.

.2 Slope water piping minimum 0.25 percent and arrange to drain at low points.

3.7 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

.1 Disinfect new and altered water distribution piping.

.2 Verify that piping system is complete and has been flushed, cleaned, inspected, and pressure tested.

.3 Isolate existing piping to full extent possible. Ensure that fixtures, existing and new that are served from piping being disinfected, are taken out of service and signs are placed at each fixture prohibiting use during the disinfection period.

.4 Schedule and perform disinfecting activities with start-up, testing, adjusting, balancing, and demonstration procedures. Coordinate with related systems.

.5 Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

.6 Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

.7 Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

.8 Maintain disinfectants in system for 24 hours.

.9 If final disinfectant residual tests less than 25 mg/L, repeat treatment.

.10 Flush disinfectants from system until residual equal to that of incoming water or 1.0 mg/L.

.11 Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze them to AWWA C651.

3.8 SCHEDULES

.1 Pipe Hanger Schedule:

.1 Metal Piping:

.1 Pipe size: 1/2" to 1-1/4" (15 to 32 mm):

.1 Maximum hanger spacing: 6.5' (2 m).

.2 Hanger rod diameter: 3/8" (9 mm).

.2 Pipe size: 1-1/2" to 2" (40 to 50 mm):

.1 Maximum hanger spacing: 10' (3 m).

.2 Hanger rod diameter: 3/8" (9 mm).

.3 Pipe size: 2-1/2" to 3" (65 to 75 mm):

.1 Maximum hanger spacing: 10' (3 m).

.2 Hanger rod diameter: 1/2" (13 mm).

END OF SECTION

1. GENERAL

1.1 GENERAL REQUIREMENTS

.1 Refer to Section 22 01 01.

1.2 REFERENCE STANDARDS

.1 CSA Group (CSA)

.1 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.

.2 CAN/CSA C22.2 No.110, Construction and Test of Electric Storage Tank Water Heaters.

.3 CAN/CSA-C191, Performance of Electric Storage Tank Water Heaters for Household Service.

.4 CAN/CSA-C309, Performance Requirements for Glass-Lined Storage Tanks for Household Hot Water Service.

.2 National Research Council Canada (NRC)

.1 National Plumbing Code of Canada (NPC).

1.3 SHOP DRAWING 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 Indicate:

.1 Equipment, including connections, fittings, control assemblies and ancillaries, identifying factory and field assembled.

1.4 CLOSEOUT SUBMITTALS

.1 Provide maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 DELIVERY, STORAGE AND HANDLING

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

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Packaging Waste Management: remove for reuse of pallets, crates, padding, and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

1.6 WARRANTY

.1 Contractor hereby warrants domestic water heaters in accordance with CCDC2, but for number of years specified for each product.

2. PRODUCTS

2.1 REFRIGERANT HEAT EXCHANGER BOOSTER HEATER

.1 Floor-standing indoor section with a modulating linear expansion device, two brazed plate refrigerant to water heat exchangers, and a sealed R-134a internal refrigerant circuit. factory assembled, wired and run tested. Factory wiring, piping, electronic modulating linear expansion device, heat exchangers, R-134a refrigerant circuit, and control circuit board contained within the unit. Provide self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Ensure indoor unit and refrigerant pipes are charged with dehydrated air before shipment from the factory.

.2 Unit Cabinet: galvanized sheet metal finish

.3 Heat Exchanger: dual brazed plate heat exchanger setup with the internal R-134a circuit capable of providing water up to 71°C (160°F)

.4 Provide a Y-Strainer to be installed on the water inlet.

.5 Piping:

- .1 Provide tubing with inner grooves for high efficiency heat exchange.
- .2 Brazed tube joints with phos-copper or silver alloy.
- .3 Coils pressure tested at the factory.

.6 Controls

- .1 Provide capability of interlocking operation with water side circulator.
- .2 Provide Capability of selecting inlet or outlet water temperature as controlled variable.
- .3 Provide capability of automatically resetting control target based on outdoor air temperature.
- .4 Provide Capability of manually resetting control target from a remote source signal.

2.2 TRIM AND INSTRUMENTATION

.1 Drain valve: NPS 1 with hose end.

.2 Thermometer: 100 mm dial type with red pointer and thermowell filled with conductive paste.

.3 Pressure gauge: 75 mm dial type with red pointer, syphon, and shut-off cock.

.4 Thermowell filled with conductive paste for control valve temperature sensor.

.5 ASME rated temperature and pressure relief valve sized for full capacity of heater or control valve, having discharge terminating over floor drain and visible to operators.

.6 Magnesium anodes adequate for 20 years of operation and located for easy replacement.

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 structural steel for horizontal mounted tanks and for instantaneous heaters.

.3 Provide insulation between tank and supports.

3.3 FIELD QUALITY CONTROL

.1 Manufacturer's factory trained, certified Engineer to start up and commission DHW heaters.

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

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 22 01 01

1.2 SECTION INCLUDES

.1 Water closets, seats, tanks, flush valves, supplies, carriers

.2 Lavatories, faucets, spouts, waste, carriers

.3 Stainless steel sinks, faucets, spouts,

.4 Service sinks, faucets, spouts, accessories

.5 Drinking water dispensers

1.3 REFERENCE STANDARDS

.1 American National Standard Institute (ANSI)

.1 ANSI Z124.1 - Gel-Coated Glass-Fibre Reinforced Polyester Resin Bathtub Units.

.2 ANSI Z124.2 - Gel-Coated Glass-Fibre Reinforced Polyester Resin Shower Receptor and Shower Stall Units.

.3 ANSI Z358.1 - Emergency Eye Wash and Shower Equipment.

.4 NSF/ANSI 42

.5 NSF/ANSI 53

.6 NSF/ANSI 61

.7 NSF/ANSI 372

.8 NSF/ANSI 401

.2 American Refrigeration Institute (ARI)

.1 ARI 1010 - Self-Contained Mechanically Refrigerated Drinking Water Coolers.

.3 American Society of Mechanical Engineers (ASME)

.1 ASME A112.6.1 - (Floor Affixed) Supports for Off-the-Floor Plumbing Fixtures for Public Use.

.2 ASME A112.18.1 - Plumbing Fixture Fittings.

.3 ASME A112.19.1 - Enameled Cast Iron Plumbing Fixtures.

.4 ASME A112.19.2 - Vitreous China Plumbing Fixtures.

.5 ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).

.6 ASME A112.19.4 - Porcelain Enameled Formed Steel Plumbing Fixtures.

.7 ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.

.4 CSA Group (CSA)

.1 CAN/CSA-C22.0 No.120 Refrigeration Equipment.

.1 CAN/CSA-B45.0 General Requirements for Plumbing Fixtures

.2 CAN/CSA-B45.1 Ceramic Plumbing Fixtures

.3 CAN/CSA-B45.2 Enameled Cast Iron Plumbing Fixtures

.4 CAN/CSA-B45.3 Porcelain-Enameled Steel Plumbing Fixtures

.5 CAN/CSA-B45.4 Stainless Steel Plumbing Fixtures

.6 CAN/CSA-B125.1 Plumbing Supply Fittings

.7 CAN/CSA-B125.2 Plumbing Waste Fittings

.8 CAN/CSA-B125.3 Plumbing Fittings

.9 CAN/CSA-B125.6 Flexible Water Connectors

1.4 ACTION AND INFORMATION SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for fixtures and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Indicate fixtures and trim:

.1 Dimensions, construction details, roughing-in dimensions.

.2 Factory-set water consumption per flush at recommended pressure.

.3 (For water closets, urinals): minimum pressure required for flushing.

.4 Provide catalogue illustrations of fixtures

1.5 CLOSEOUT SUBMITTALS

.1 Description of fixtures and trim, giving manufacturer's name, type, model, year, capacity.

.2 Details of operation, servicing, maintenance.

.3 List of recommended spare parts.

.4 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum five years documented experience.

.2 Installer Qualifications: trades license with minimum five years' documented experience.

1.7 REGULATORY REQUIREMENTS

.1 Products Requiring Electrical Connection: Listed and classified by CSA, ULC, cUL or Special Inspection as suitable for the purpose specified and indicated.

1.8 MOCK-UP

.1 Refer to Division 01: Requirements for mock-up.

.2 Provide mock-up of typical bathroom group.

.3 Mock-up may remain as part of the Work, if approved by Consultant.

1.9 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:

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

.2 Store and protect specified materials from nicks, scratches, blemishes, theft vandalism and vermin.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

.5 Accept fixtures on site in factory packaging. Inspect for damage.

.6 Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

2 PRODUCTS

2.1 MANUFACTURERS

.1 All plumbing fixtures, fixture trim and accessories shall be products of one manufacturer to the extent that this is possible.

.2 Carriers

.1 Manufacturer: Watts

.2 Other acceptable manufacturers offering equivalent products.

.1 Zurn

.2 J. R. Smith

.3 MIFAB

2.2 WATER CLOSET, FLOOR MOUNTED, 2-PC, ELONGATED BOWL

.1 Bowl: white vitreous china, two-piece close coupled toilet combination, elongated rim bowl, fully glazed internal trapway, syphon jet flush action, ceramic glaze, universal height, bolt caps, lined tank complete with fittings, chrome-plated trip lever, 1.6 Gal (6 L) flush, and bolted cover.

.1 Toto Drake CST 776 CSFG

.2 Finish: Cotton

.2 Seat: white, open front, elongated, solid plastic, with cover.

.1 Centoco 620-001

.3 Supply: Heavy pattern chrome-plated quarter-turn brass ball valve with convertible loose key handle, chrome-plated copper riser and forged brass flange with setscrew, ½” sweat connection x 3/8” O.D. and 12” riser.

.1 McGuire H172BV

2.3 LAVATORY, WALL-HUNG

.1 Lavatory: 24-1/4” x 18-1/8” washbasin wall-mount c/w overflow. Provide right or left hand version as directed by Architect.

.2 Faucet: Single lever handle for volume and temperature control, 140mm spout, 4.5 lpm maximum flow at 60 psi, c/w metal pop-up and tail-piece, single hole installation, pre-attached flexible supply lines. Complies with ASME A112.18.1/CSA B125.1, NSF 61 and 372, ADA,

.3 Drain: C.P., cast brass 1 pc. top, 17ga. (1.5mm), 1-1/4" (32mm) tailpiece. Full assembly shall be treated inside and out with 'SANIGUARD' antimicrobial compound

.4 Supplies: C.P., polished brass, rigid horizontal nipple 3/8" (9.5mm) x 5" (127mm) long I.P.S., heavy all brass angle stops, with V.P. loose key, escutcheons and flexible copper risers

.5 Trap: C.P., polished, cast brass adjustable body, 1-1/4" (32mm) with cleanout plug, seamless brass wall bend and escutcheon. Full Assembly shall be treated inside and out with 'SANIGUARD' antimicrobial compound.

.6 Thermostatic mixing valve: ASSE 1017, ASSE 1069, and ASSE 1070 certified and IAPMO cUPC certified and approved to CSA B125.3 and CSA B125.70. Lead

Free* cast copper silicon alloy body. Includes integral filter washers and check valves and an adjustment cap with locking feature. Provided with threaded (-UT), solder (-US), PEX (-PEX), PEX F1960 cold expansion fittings (-CEF), CPVC (-CPVC), QuickConnect (-QC) or w/press, union connections as required.

.7 Carrier: concealed arms and steel pipe legs, welded to block base feet support. (For narrow wall installation provide 'Z' type sleeve for arms).

.8 Manufacturers:

.1 Lavatory: Duravit Scola 0684600011

.2 Faucet: Kohler Purist K-14402-4A

.3 Drain: McGuire #155ASAN-LO Basin Drain

.4 Supplies: McGuire #H165LKN5 Supplies

.5 Trap: McGuire #8872CBSAN 'p' Trap.

.6 Thermostatic Mixing Valve: Watts LFMMVM1

.7 Carrier: Watts

2.4 SINK, ONE COMPARTMENT, GOOSENECK SPOUT, SINGLE LEVER

.1 Sink: Single, squared bowl, 381 x 381 x 237 deep, 16-ga stainless steel construction, undermount c/w installation hardware, sound absorption pads, meets ASME B112.19.3/CSA B45.4, ADA

.2 Faucet: Metal construction, one piece, self-contained ceramic disk for volume and temperature control, w/o side spray, single-hole mounting, 20.3cm spout reach, 6.8 Lpm maximum flow rate, polished chrome finish, meets ASME B112.18.1/CSA B125.1, ADA, NSF 61

.3 Supplies: C.P. Polished Brass, rigid horizontal nipples 3/8" (10mm) x 5" (127mm) long, I.P.S. heavy all brass angle stops with wheel handle stops, escutcheons and with flexible copper risers.

.4 Trap: C.P., polished cast brass adjustable body, 1-1/2" (38mm) with cleanout plug, seamless brass wall bend and escutcheon. Full assembly shall be treated inside and out with 'SANIGUARD' antimicrobial compound.

.5 Thermostatic mixing valve: ASSE 1017, ASSE 1069, and ASSE 1070 certified and IAPMO cUPC certified and approved to CSA B125.3 and CSA B125.70. Lead Free* cast copper silicon alloy body. Includes integral filter washers and check valves and an adjustment cap with locking feature. Provided with threaded (-UT), solder (-US), PEX (-PEX), PEX F1960 cold expansion fittings (-CEF), CPVC (-CPVC), QuickConnect (-QC) or w/press, union connections as required.

.6 Manufacturers:

.1 Sink: Kohler Strive K-5287

.2 Faucet: Kohler Purist K7507

.3 Supplies: McGuire #H165N5 Supplies

.4 Trap: McGuire #8912CBSAN 'P' Trap

.5 Thermostatic Mixing Valve: Watts LFMMVM1

2.5 SINK, DOUBLE COMPARTMENT, GOOSENECK SPOUT, SINGLE LEVER

.1 Sink: Double (large/medium) compartment, squared bowl, 838 x 457 x 241 deep, 16-ga stainless steel construction, undermount c/w installation hardware, sound absorption pads, meets ASME B112.19.3/CSA B45.4, ADA. Compartments: 356 x 271 and 462 x 356. C/w cutting board, sink rack and hardware kit.

.2 Faucet: Metal construction, one piece, self-contained ceramic disk for volume and temperature control, w/o side spray, single-hole mounting, 20.3cm spout reach, 6.8 Lpm maximum flow rate, polished chrome finish, meets ASME B112.18.1/CSA B125.1, ADA, NSF 61

.3 Supplies: C.P. Polished Brass, rigid horizontal nipples 3/8" (10mm) x 5" (127mm) long, I.P.S. heavy all brass angle stops with wheel handle stops, escutcheons and with flexible copper risers.

.4 Trap: C.P., polished cast brass adjustable body, 1-1/2" (38mm) with cleanout plug, seamless brass wall bend and escutcheon. Full assembly shall be treated inside and out with 'SANIGUARD' antimicrobial compound.

.5 Thermostatic mixing valve: ASSE 1017, ASSE 1069, and ASSE 1070 certified and IAPMO cUPC certified and approved to CSA B125.3 and CSA B125.70. Lead Free* cast copper silicon alloy body. Includes integral filter washers and check valves and an adjustment cap with locking feature. Provided with threaded (-UT), solder (-US), PEX (-PEX), PEX F1960 cold expansion fittings (-CEF), CPVC (-CPVC), QuickConnect (-QC) or w/press, union connections as required.

.6 Manufacturers:

.1 Sink: Kohler Poise K-3160

.2 Faucet: Kohler Purist K7507

.3 Supplies: McGuire #H165N5 Supplies

.4 Trap: McGuire #8912CBSAN 'P' Trap

.5 Thermostatic Mixing Valve: Watts LFMMVM1

2.6 SERVICE SINK

.1 Sink: Single bowl scullery sink, 16 gauge, T316 stainless steel, 690 x 700 x 360 deep, #4 satin finish, adjustable bullet feet, integral backsplash, rolled edge at front and sides, c/w 89 diameter basket strainer assembly with tailpiece. 203 centre two-hole drilling, 850 top edge of bowl.

.2 Faucet: 8" (203 mm) exposed wallmount service sink faucet, integral stops, rigid pail hook top brace, threaded spout, body mounted vacuum breaker, single blade tamperproof lever handle, 51 Lpm flow at 4.1 bar, solid brass construction with chrome plated exterior.

.3 Trap: Heavy cast brass 1 1/2 x 2 adjustable trap with cleanout plug and 13-3/4 inch center to end. Furnished with slip nuts, seamless tubular brass wall bend and steel set screw flange.

.1 Sink: Novanni 7501/316 - 28

.2 Faucet: Kohler Triton Bowe K837T60-4A

.3 Trap: McGuire 8904C: 2IN X 2IN

2.7 DRINKING WATER DISPENSER

.1 Built-in filtered water dispenser, non-refrigerated, Aspen white, complete with Ambient Water, Automatic Filter Status Reset, Green Ticker, hands-free operations, laminar flow dispensing, visual filter monitor. Provide built-in unit for indoor application certified to UL 399.

.1 Power – 115V/60Hz

.2 FLA – 1 amp

.3 Rated Watts – 25

.4 Dimensions – 5-1/8” x 18” x 18”, 40 lb

.2 Provide unit complete with LED filter status indicator for when filter change is necessary.

.3 Provide PFOA/PFAS filter tested and certified to NSF/ANSI 42, 53 and 401 for the reduction of PFOA and PFOS, lead, microplastics, Class 1 particulate, cysts, and chlorine taste and odor with 2,250 gallon capacity.

.4 Provide unit with Green Ticker counter that informs the number of 16.9 oz plastic water bottles saved from waste.

.5 Provide unit with laminar flow to provide a clean fill with minimal splashing.

.6 Product compliance: ADA & ICC A117.1, CAN/CSA C22.2 No 120, FCC & ISED, NSF/ANSI 42, 53, 61, 372 (lead free), & 401, UL 399. Labelled cULus and IAPMO R&T.

.7 Provide unit with access panel as required for installation.

.8 Manufacturer

.1 Dispenser: Elkay LBWD00WHC

.2 Trap: McGuire 1-1/4” x 1-1/4” (non-metallic).

3 EXECUTION

3.1 EXAMINATION AND PREPARATION

.1 Verify that walls and floor finishes are prepared and ready for installation of

fixtures.

.2 Verify that electric power is available and of the correct characteristics.

3.2 PREPARATION

.1 Rough-in fixture piping connections to minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

.1 Install each fixture with trap, easily removable for servicing and cleaning.

.2 Provide chrome plated rigid supplies to fixtures with screwdriver stops, reducers, and escutcheons.

.3 Install components level and plumb.

.4 Install and secure floor mounted fixtures in place with bolts.

.5 Seal fixtures to wall and floor surfaces with sealant having VOC content not exceeding 250 g/L. Colour to match fixture.

3.4 ADJUSTING

.1 Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.5 CLEANING

.1 Clean plumbing fixtures and equipment.

3.6 PROTECTION OF FINISHED WORK

.1 Do not permit use of fixtures.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Read and conform to:

.1 The Contract CCDC 2-2008, Stipulated Price Contract as amended,

.2 Division 1 requirements and documents referred to therein.

.2 Section 23 01 01 applies to and governs the work of Division 23.

.3 The technical Sections of this Division are generally divided into units of work for the purpose of ready reference. The division of the work among subcontractors is not the Consultant's responsibility and the Consultant assumes no responsibility to act as an arbiter and/or to establish subcontract limits between any Sections of the work.

.4 The specifications are integral with the drawings which accompany them. Neither is to be used alone. Any item or subject omitted from one but implied in the other is fully and properly required.

.5 Wherever differences occur in the tender documents, the most onerous condition governs. Base the bid on the costliest arrangement.

1.2 DEFINITIONS

.1 The following are definitions of words found in this specification and on associated drawings under this Division:

.1	"Concealed"	locations hidden from normal sight in furred spaces, shafts, ceiling spaces, walls, and partitions.
.2	"Exposed"	mechanical work normally visible to building occupants.
.3	"Furnish"	(and its derivatives) has the same meaning as the term "Supply".
.4	"Install"	(and its derivatives) - receive, store and handle at the site, mount and support and connect all required services. Includes adjustment and calibration, testing, commissioning, inspection by authorities having jurisdiction and documentation.
.5	"Provide"	(and its derivatives) - supply, install in place, connect the associated required services ready for operation, adjust and calibrate, test, commission, warrant, and document. Includes inspection by authorities having jurisdiction.
.6	"Supply"	(and its derivatives) purchase and deliver to the site for installation. Includes submittals, manufacturer's field inspection and warranty.

.7 "Wet" locations exposed to moisture, requiring special materials and arrangement.

1.3 WORK INCLUDED

.1 Products and methods mentioned or shown in the Contract Documents complete with incidentals necessary for a complete operating installation. Provide tools, equipment and services required to do the work.

.2 Identification of equipment, piping, ductwork, valves, and controllers.

.3 Motors required for equipment supplied under this Division.

.4 Variable frequency drives for motors and equipment supplied by this Division.

.5 Internal wiring, relays, contactors, switches, transformers, motor starters, and all controls necessary for the intended operation, furnished with terminals and external controls suitable for connection to power source at a single easily accessed location for equipment items that are supplied with motors and/or electrical or electronic components under this Division.

.6 Refer to Mechanical/Electrical Equipment Schedule for extent of wiring and electrical characteristics.

.7 Verify the correct operation of each equipment item provided and/or altered and each system in total and obtain the Owner's approval prior to starting and/or returning to operation.

1.4 RELATED WORK

.1 Power wiring, conduit, and connections for motors under this Division will be by Division 26.

.2 Power wiring, conduit, and connections to variable frequency drives for motors under this Division will be by Division 26. Wiring and connections from VFD to motors under this Division will be by Division 26.

.3 Flashings for mechanical equipment and services located on or passing through roofs will be provided under Division 7. Supply counter flashings, and integral flashing collars on equipment and piping under this Division.

.4 Painting of exposed piping and ductwork other than for identification will be supplied under Division 9.

1.5 SUBMITTALS

.1 Approval Drawings: Prepare and submit drawings necessary for approval to any authority having jurisdiction and obtain two (2) copies of approved drawings for retention by Consultant prior to commencement of work under this Division.

.2 Shop Drawings: Prepare and submit two (2) hard copies and one (1) electronic copy of shop drawings of major equipment items (including those items specifically indicated under Part 1: General of each Section), to the Consultant for review. The Consultant will return one copy, marked with comments and his

review stamp as he deems appropriate. Prepare the necessary number of copies of the returned set and distribute to the Owner, the Prime Consultant, the General Contractor, the site, and to subcontractors and suppliers.

.1 Clearly indicate manufacturer's and supplier's names, catalogue model numbers, details of construction, accurate dimensions, capacities and performance. Prior to submission check and certify as correct, shop drawings and data sheets. Do not order equipment until a copy of the shop drawings, reviewed by Consultant, has been returned to Contractor.

.2 Clearly indicate the weight, location, method of support and anchor point forces and locations for each piece of equipment on shop drawings.

.3 The Consultant will not review shop drawings that fail to bear the Contractor's stamp of approval or certification.

.4 Read the following in conjunction with the wording on the shop drawing review stamp applied to each and every drawing submitted:

"*This review by the Consultant is for the sole purpose of ascertaining conformance with general design concept. This review shall not mean that the Consultant approves the detail design inherent in the shop drawings, responsibility for which shall remain with the Contractor submitting same, and such review shall not relieve the Contractor of his responsibility for errors or omissions in the shop drawings or of his responsibility for meeting all requirements of the Contract Documents. The Contractor is responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for coordination of the work of all sub trades*."

.3 Composite Wiring Diagrams: Prepare and submit three (3) copies of complete composite wiring diagrams of each specific mechanical system. Indicate all electrical equipment and wiring, both internal and external, for review and coordination of trades.

.4 Contractor's Material and Test Certificates: Prepare and submit certificates for each system installed. Where certificates are prescribed by regulations, codes or standards ensure they conform to the requirements of those documents. Include a copy of each certificate in the Operation and Maintenance manual. Certificates shall include the following:

.1 description of the system (description and type),

.2 description of the tests conducted, and results observed, including re-testing, where necessary,

.3 description of any corrective measures undertaken,

.4 description of materials used (pipe and fittings),

.5 list of witnesses for each test conducted,

.6 date system left ready for service,

.7 signature of installing Contractor.

.5 Directories & Schematics

.1 Submit five (5) copies of a neat typewritten directory indicating the valve number, related service, and location of each valve under this Division.

.2 Submit five (5) copies of system control schematics for each mechanical system indicating relative locations of equipment and control devices.

.3 Enclose one (1) copy of each directory/schematic under glass in a neat polished 18" x 24" (460 mm x 610 mm) metal frame, complete with mounting clips.

.6 Maintenance Data and Operating Instructions

.1 Submit three (3) copies of Operation and Maintenance Manual individually bound in hard backed three-ring binders.

.2 Ensure the binder spines have typewritten lettering as follows:

OPERATION & MAINTENANCE MANUAL

for

[Insert project name]

[Insert date of submission]

Division 23 00 00

.3 Provide a list of names, addresses and telephone numbers of equipment suppliers, installing contractors, general contractors, architect and Consultant. Include special telephone numbers for service departments on normal and emergency call basis.

.4 Provide descriptive literature (shop drawings) of each manufactured item. Include a bill of material with purchase order numbers and vendor's identification of equipment orders for each item.

.5 Include copies of start-up reports and checklists and all certificates issued with respect to this contract.

.6 Ensure operating instructions include the following:

.1 General description of each mechanical system.

.2 Step by step procedure to follow in putting each piece of equipment into service.

.3 Schematic control diagrams for each separate mechanical system, control thermometers, freezestats, firestats, pressure gauges, automatic valves, and refrigeration accessories. Mark correct operating settings for each control device on these diagrams.

.4 Diagram of the electrical control system indicating the wiring of related electrical components such as PE and EP switches,

firestats, freezestats, fuses, interlocks, electrical switches and relays.

.5 Drawings of each control panel including temperature control and electrical panels, completely identifying components on the panels and their function.

.7 Ensure maintenance instructions include the following:

.1 Manufacturer's maintenance instructions for each item of mechanical equipment installed under this Division. Instructions shall include installation instructions, parts numbers and lists, name of supplier and maintenance and lubrication instructions.

.2 Summary list of each item of mechanical equipment requiring lubrication, indicating the name of the equipment item, location of all points of lubrication, type of lubricant recommended, and frequency of lubrication.

.3 Equipment directory indicating name, model, serial number and nameplate data of each item of equipment supplied, and system with which it is associated.

.4 Balancing and testing reports.

.5 Copy of valve directory.

.7 As-Built Records: Prepare and submit complete as-built records prior to Substantial Performance of the Contract. Refer to Division 1 regarding requirements. Submit two sets of as-builts drawings in AutoCAD format showing changes & concealed services dimensioned. AutoCAD files can be provided to the contractor by the Consultant at a fee of $300.00 plus $25.00 per sheet upon request.

1.6 QUALITY ASSURANCE

.1 Conform to minimum requirements or better of provincial and local codes, where existing, and to requirements of local inspection authorities for execution of work under this Division.

.2 Ensure materials supplied under this Division conform to minimum requirements and recommendations or better of applicable standards of the following:

.3 Use latest editions and amendments in effect on date of Bid call subject to requirements of OBC.

.4 Arrange and pay for permits and inspections by authorities having jurisdiction, required in the undertaking of this Division. Make modifications required by authorities.

.5 Ensure tradesmen employed on the project hold valid trade certificates/licenses and make a copy available for review by the Consultant and/or Owner when requested.

.6 Ensure welding and brazing is executed by certified welders in accordance with

registered procedures.

.7 Ensure refrigeration work is executed only by mechanics with valid ODP cards.

1.7 PRODUCT DELIVERY, HANDLING AND STORAGE

.1 Immediately after letting of contract, review material and equipment requirements for this work, determine supply and delivery dates for all items, and notify Consultant of any potential delays in completion of this project in order that remedial action may be taken.

.2 Store neatly out of the way and protected from damage and theft, materials and equipment supplied under this Division that are received at the site by this Division.

1.8 JOB CONDITIONS

.1 Visit site and examine existing conditions which may affect work of this Division.

.2 Examine all Contract Documents to ensure that work of this Division may be satisfactorily completed.

.3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.

.4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without qualifications, unless exceptions are specifically noted in the Bid.

1.9 WARRANTY

.1 Refer to General Conditions. Arrange with each manufacturer/supplier to extend warranties as necessary to coincide with warranty period or those periods specified.

.2 Make submissions necessary to register product warranties to the benefit of the Owner.

.3 Submit to Consultant, prior to Substantial Performance of the Contract, manufacturer's written warranties covering periods longer than one year or offering greater benefits than required in specifications and in the Owner's name.

1.10 INTERRUPTIONS

.1 Arrange execution of work to maintain present building operations, and to minimize the effect of work under this Division on existing operations.

.2 Prior to interrupting any existing service notify the Owner and Consultant, in writing, at least 7 days in advance, and obtain written authorization. Do not interrupt any existing service without Consultant's specific authorization. Refer to Division 1 for requirements.

.3 Arrange time and duration of interruption through the Owner's Physical Plant

Department. Include in Bid Price for all overtime or premium time hours necessary to minimize duration of service interruption.

.4 Test and verify the proper operation of existing equipment and systems that are shut down due to work of this project, prior to returning to service.

.5 Assume responsibility for consequential costs on failure to obtain permission to shut down and/or start-up any item of equipment, system or service.

1.11 EXTRAS AND CREDITS

.1 Accompany price submissions requested by Consultant for extra work, or work to be deleted, with a complete cost breakdown as follows:

.1 Materials, quantities, and unit costs including any applicable contractors trade discount clearly identified. Provide supplier quotations.

.2 Labour hours and unit costs.

.3 Total materials and labour costs.

.4 Overhead and profit mark-ups in accordance with the General Conditions of the Contract.

.2 Quotations from software such as Allpriser will not be accepted. Provide actual material costs.

1.12 PHASING AND SCHEDULING

.1 Phase the work as required to support commissioning, start-up & construction services.

.2 All phasing shall be in correspondence & agreement with the general contractor.

.3 The contractor shall comprehend construction activities in conjunction with the general contractor & perform phasing as such to support construction activities.

.4 Coordinate work of all Sections of Division 23 with other trades and assist in the development of the Phasing Strategy.

.5 Refer to O.B.C. Division C, Part 1, Subsection 1.3.3 Occupancy of Unfinished Building

.6 Where occupancy of a part of the work is required prior to completion of the entire project, ensure that equipment, systems and services that serve the areas to be occupied are completed, tested and fully operational 2-weeks prior to scheduled turn over and ensure that reports, certifcates and documentation are submitted at that time.

2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

.1 Ensure materials and equipment provided under this Division are new and free

from defects and bear labels of approval as required by codes referred to in this Division and/or by inspection authorities.

.2 Ensure apparatus and equipment provided under this Division bears manufacturer's nameplate indicating name of manufacturer, model number or type, size, capacity, CRN, and other pertinent information. Ensure nameplates are easily read and clearly visible, with openings provided where equipment is insulated.

.3 Ensure manufacturers and suppliers of equipment or materials under this Division determine if their products are composed of any hazardous materials. If they are, the products are suitably labeled and supplied with Material Safety Data sheets. Obtain the Owner's approval in writing to bring hazardous materials onto the site prior to doing so.

.4 When utilizing any products that are hazardous, keep Material Safety Data sheets on file at the job site and present them to anyone requesting this information. When transferring hazardous materials from original container into other containers, provide Workplace Labels on such containers.

2.2 ACCEPTABLE PRODUCTS

.1 First item named or specified by catalogue number meets specifications regarding performance, quality of material and workmanship, and is acceptable to the Consultant.

.2 Items, other than first named, meeting specifications regarding quality of materials and workmanship are acceptable to the Consultant, only, if they also meet performance and/or capacities specified and can be accommodated within the space allotted.

.3 General approval indicated by inclusion of other manufacturers named is subject to final review of shop drawings, performance data and test reports.

2.3 EQUIVALENTS AND ALTERNATIVES

.1 Suppliers wishing approval for additional equipment items or alternatives as equivalent to those specified must submit complete description, technical and performance data to Consultant at least twelve (12) working days prior to Bid closing date. Equivalent equipment, if accepted, must conform to specifications with regard to details, accessories, modifications, features and performance. Deviations from specifications must be stated in writing at time of submission for approval.

.2 Bid Prices shall include only products specified or approved equivalents.

2.4 SUBSTITUTIONS DURING PROGRESS OF WORK

.1 Refer to Section 01 25 00.

2.5 CONSULTANT'S REVIEW

.1 The consultants will review and evaluate unsolicited alternatives and substitutions proposed by the Contractor. Such review and evaluation work will be undertaken by the Consultant on an additional fee basis. Reimburse the Owner for costs associated with such reviews and evaluations.

.2 Reimburse the Owner for costs incurred in updating Contract Documents to reflect such changes.

3 EXECUTION

3.1 RELATIONSHIP WITH OTHER TRADES

.1 Cooperate with other trades whose work affects or is affected by work of this Division to ensure satisfactory installation and to avoid delays.

.2 Provide materials to be built-in, such as sleeves, anchors, and inserts, together with templates and/or measurements, promptly when required by other trades.

.3 Provide structural supports for equipment to be mounted on or in walls, supported above floors and/or suspended from the structure.

3.2 INSTALLATION REQUIREMENTS

.1 The Consultant's drawings and instructions govern the location of all items. Prepare fully coordinated installation drawings prior to installation.

.2 Install equipment neatly to the satisfaction of the Consultant. Unless noted otherwise install products and services to follow building planes. Ensure installation permits free use of space and maximum headroom.

.3 Confirm the exact location of outlets, fixtures and connections. Confirm location of outlets for equipment supplied under other Divisions.

.4 Install equipment and apparatus to allow free access for maintenance, adjustment and eventual replacement.

.5 Provide suitable shielding and physical protection for devices.

.6 Install products and services in accordance with the manufacturer's requirements and/or recommendations.

.7 Provide bases, supports, hangers and fasteners. Secure products and services so as not to impose undue stresses on the structure and systems.

.8 Do not use powder activated tools without written permission of the Consultant. Use them in accordance with the Owner's health and safety policies.

.9 Ensure that the load onto structures does not exceed the maximum loading per square metre indicated on the structural drawings or as directed by the Consultant.

3.3 CONTRACT DRAWINGS

.1 The drawings of this Division are performance drawings and indicate general

arrangement of the work. They are diagrammatic except where specific details are given.

.2 Obtain accurate dimensions from the architectural and structural drawings, or by measurement. Location and elevation of services are approximate. Verify them before construction is undertaken.

.3 Make changes where required to accommodate structural conditions, (beams, columns, etc.). Obtain Consultant's approval before proceeding.

.4 Adjust the location of materials and/or equipment as directed without adjustment to contract price, provided that the changes are requested before installation and do not affect material quantity. **Note that outlets and/or equipment may be relocated up to 10 feet (3 m) in any direction without a change to the contract price.**

.5 Note that the layout and orientation of the ceiling outlets on the architectural reflected ceiling drawings may differ from that shown on the mechanical drawings. Make the installation in accordance with the latest architectural ceiling drawings. Provide the equipment as specified and/or shown on the documents of this Division.

.6 The drawings of this Division are intended for tender pricing. The quantities and quality to be included in the bid price shall be based on the layout and specifications as shown on the mechanical documents. If there is a difference in quantity between the architectural and drawings of this Division, base the contract price on the greater quantity.

.7 Prepare installation (construction) drawing to reflect the latest architectural ceiling layout.

3.4 CONSTRUCTION DRAWINGS

.1 Prepare fully dimensioned drawings showing devices, fixtures, equipment, outlets, sleeves and openings through structure. Indicate locations and weights on load points.

.2 Prepare fully dimensioned construction drawings of products and services suitably interfaced with work of the sub-trades, in mechanical rooms, service and ceiling spaces, and other critical locations. Coordinate the work with other divisions. Base drawings on reviewed shop drawings and latest architectural drawings. Indicate details pertaining to the following: access, clearances, cleanouts, sleeves, electrical connections, drain locations and elevation of pipes, ducts, conduits.

.3 Prepare drawings of pits, curbs, sills, equipment bases, anchors, inertia slabs, etc.

.4 Submit construction drawings to other Divisions. Provide one (1) transparency and four (4) print copies of construction drawings to the Consultant for record purposes.

.5 Submit construction drawings prior to commencement of work.

3.5 RECORD DRAWINGS

.1 Maintain project "as-built" record drawings. Obtain white prints from the Consultant for this purpose and pay printing costs. Identify each set as "Project Record Copy".

.2 Record deviations from contract documents caused by site conditions or by changes ordered by the Consultant. Record deviations in red ink clearly and accurately, using industry standard drafting procedures consistent with quality and standards of Consultants documents.

.3 Record deviations as work progresses throughout the execution of this contract. Maintain record drawings on site in clean, dry, legible condition, making them available for periodic review by the Consultant.

.4 Record location of concealed services, particularly underground services. Before commencing any backfilling, obtain accurate measurements and information concerning correct location and depth of services.

3.6 USE OF SYSTEMS

.1 For the duration of this contract, do not use any piece of equipment provided under this contract for the purposes of heating, ventilation, or air conditioning without the specific authorization of the Owner and Consultant. Ensure the building is "broom clean" and painting is finished before asking permission for testing to commence.

.2 Where specific written authorization is given for the use of equipment while work is still in progress, seal off ductwork, grilles, diffusers, and registers or other openings to the air distribution systems or air handling equipment that is not in use.

.3 Use of new and/or existing permanent heating and/or ventilating systems for supplying temporary heat or ventilation is [not permitted] [permitted only under following conditions:]

.1 Entire system is complete, pressure tested, cleaned, flushed out.

.2 Specified water treatment systems have been commissioned, and water treatment is being continuously monitored.

.3 Building has been closed in, areas to be heated/ventilated are clean and will not thereafter be subjected to dust-producing processes.

.4 There is no possibility of damage.

.5 Supply ventilation systems are protected by 60 % filters, inspected daily, changed every week or more frequently as required.

.6 Return systems have approved filters over openings, inlets, and outlets.

.7 Operate systems as per manufacturer's recommendations and instructions.

.8 Monitor systems continuously.

.9 Warranties and guarantees are not relaxed.

.10 Perform regular preventive and other manufacturers recommended maintenance routines under supervision of Consultant.

.11 Refurbish entire system before static completion; clean internally and externally, restore to "as- new" condition, replace filters in air systems.

.4 Filters specified in this Section are over and above those specified in other Sections of this project.

.5 Exhaust systems are not included in approvals for temporary heating and ventilation.

3.7 SPECIAL TOOLS AND SPARE PARTS

.1 Within 30 days of award of contract, prepare a complete itemized list of spare parts and submit to Consultant for review. List will be used as a checklist and should include provision for sign off by the Owner on receipt.

.2 On completion of the project furnish spare parts to the Owner as follows:

.1 One set of new filters for each filter bank installed (per equipment).

.3 Identify spare parts containers as to contents and replacement parts number.

3.8 INSTRUCTION

.1 Instruct and familiarize Owner's operating personnel with the various mechanical systems. Arrange instruction for each system separately.

.2 Provide instruction for each system on two separate occasions, coordinated with the Owner's staff operating schedule, in order that interested personnel may arrange to attend.

.3 Ensure each instruction period includes, but is not limited to the following:

.1 a classroom seminar with operating manuals, product and system drawings and such other audio/visual aids as may be appropriate,

.2 instruction during the classroom seminar by the manufacturer's representative regarding the proper operating and maintenance procedures for each item of equipment,

.3 demonstration of the proper operating procedures for each item of equipment,

.4 explanation of the purpose and function of all safety devices provided,

.5 demonstration of all measures required for safe and proper access for operation and maintenance.

.4 Provide a period of follow-up instruction (on two occasions) approximately one month after completing Owner's instruction to clarify and reinforce earlier instructions.

.5 Submit a letter from the Owner's management staff indicating the instruction has

been given satisfactorily to the Consultant prior to substantial completion of the project.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 01 01.

1.2 WORK INCLUDED

.1 Identification of existing services and utility connections.

.2 Installation, protection and maintenance of temporary services as required to support continuing operation of the facility.

.3 Disconnection and making safe of various mechanical systems and equipment in areas to be demolished and/or renovated.

.4 Disposal of waste materials in accordance with waste management requirements.

.5 Re-certification and inspection of changes made to any equipment, machine or apparatus by authorities having jurisdiction including requirements for marking of equipment.

1.3 REGULATORY REQUIREMENTS

.1 Notify authorities of intent to demolish and the schedule for the work. Obtain required permits from authorities.

.2 Conform to codes for demolition work, dust control, products requiring disconnection and re-connection.

.3 Do not close or obstruct egress width to any building or site exit.

.4 Do not disable or disrupt building fire or life safety systems without 3 days prior written notice to Owner.

.5 Conform to procedures applicable when hazardous or contaminated materials are discovered.

.6 Arrange for re-certification and inspection of changes made to any equipment, machine or apparatus by authorities having jurisdiction. This includes requirements for marking equipment under rules 2-100 and 2-102 of the Ontario Electrical Safety Code.

1.4 JOB CONDITIONS

.1 Visit site and examine existing conditions which may affect work of this Division.

.2 Examine Contract Documents to ensure that work of this Division may be satisfactorily completed.

.3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.

.4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without qualifications, unless exceptions are specifically noted in the Bid.

1.5 INTERRUPTIONS

.1 Arrange execution of work to maintain present building operations, and to minimize the effect of work under this Division on existing operations.

.2 Prior to interrupting any existing service notify the Owner and Consultant, in writing, at least 7 days in advance, and obtain written authorization. Do not interrupt any existing service without Consultant's specific authorization. Refer to Division 1 for requirements.

.3 Include in Bid Price for overtime or premium time hours necessary to minimize duration of service interruption.

.4 Test and verify the proper operation of existing equipment and systems that are shut down due to work of this project, prior to returning to service.

.5 Assume responsibility for consequential costs on failure to obtain permission to shut down and/or start up equipment, system or service.

1.6 PHASING AND SCHEDULING

.1 Refer to Division 1 phasing and scheduling of the work.

.2 Coordinate the work of all Sections of Division 23 with other trades and assist in the development of the Phasing Strategy.

2 PRODUCTS

Not Applicable

3 EXECUTION

3.1 PREPARATION

.1 Prior to start of work under this Section, ensure:

.1 Provide, erect, and maintain temporary barriers at locations indicated.

.2 Erect and maintain weatherproof closures for exterior openings.

.3 Erect and maintain temporary partitions to prevent spread of dust, odors, and noise to permit continued Owner occupancy.

.4 Prevent movement of structure; provide bracing and shoring.

.2 Install, protect and maintain temporary services as required to support continuing operation of the facility.

.3 Protect services and equipment which are not to be demolished.

.4 Coordinate service shutdowns with Owner's project coordinator. Provide notice

as required by Owner and submit schedule for the work.

.5 Notify affected utility companies before starting work and comply with their requirements.

.6 Mark location and termination of utilities.

.7 Provide appropriate temporary signage including signage for exit or building egress.

3.2 RELATIONSHIP WITH OTHER TRADES

.1 Cooperate with other trades whose work affects or is affected by work of this Division to ensure satisfactory installation and to avoid delays.

.2 Remove and dispose of built-in items such as sleeves, anchors, and inserts.

.3 Remove and dispose of bases, supports and anchors for piping, equipment and ductwork mounted on or in walls, and/or suspended from the structure.

3.3 PROTECTION

.1 Protect existing and new work to remain free from damage due to execution of work under this Division with tarpaulins and other protective coverings as necessary.

.2 Repair damage to the building and components resulting from failure to provide sufficient protection, to the satisfaction of the Consultant.

.3 Fit existing air intake and exhaust openings that may be affected by dust and/or debris from the construction work with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Closely monitor filters and replace them when necessary. Replace existing filters that become contaminated with dust and/or debris from construction work with new filters.

.4 If dust and debris from construction work does penetrate the building and/or its air distribution systems, clean the affected areas and/or systems.

.5 Remove temporary filters on completion of the construction works.

3.4 DEMOLITION

.1 Notify authorities of intent to demolish and the schedule for the work.

.2 Conform to codes, regulations, standards and bylaws applicable to the work.

.3 Protect existing equipment and services to remain from debris and unwanted materials. Clean as necessary to maintain service during demolition period and on completion of the work.

.4 Coordinate service shutdowns with Owner's project coordinator. Provide notice as required by Owner and submit schedule for the work.

.5 Remove and dispose of redundant mechanical services and equipment within the limits of the demolition site and where demolished systems extend beyond these

limits.

.6 Conform to Occupational Health & Safety and Environmental regulations. Ensure that parties are familiar with requirements and experienced in the work to be undertaken.

.7 Conform to the requirements of Division 01, municipal By-Laws and Ministry of the Environment regulations and standards for waste disposal.

.8 Fit existing air intake and exhaust openings that may be affected by dust and/or debris from the demolition work with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Closely monitor filters and replace them when necessary. Replace existing filters that become contaminated with dust and/or debris from demolition work with new filters.

.9 If dust and debris from demolition work does penetrate the building and/or its air distribution systems, clean the affected areas and/or systems.

.10 Disconnect remove, cap and identify all utilities within demolition areas.

.11 Demolish in an orderly and careful manner. Protect existing supporting structural members.

.12 Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.

.13 Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.

.14 Remove temporary Work.

3.5 RENOVATIONS

.1 Isolate and drain systems as required to effect renovations, modifications and/or repairs. On completion of renovations, modifications and/or repairs, test entire system as if it was new. Report repairs or replacements required of existing equipment, piping, fittings or devices that are not included in contract to Consultant and Owner for instruction. Flush, clean and refill renovated systems as specified for new.

.2 Relocate or remove existing items so designated unless specifically indicated to be relocated or removed under other Sections.

.3 Clean and repair existing items to be relocated. Alter as required to suit new location. Replace damaged or ineffective parts to make items "as new".

.4 Existing items to be removed remain the property of the owner and shall be delivered to a location on site designated by the owner. If the owner declares no interest in the removed items, assume ownership and remove the items from the site.

.5 Make good surfaces and finishes in areas from which items have been removed and in which items are relocated. Cap existing services required to be severed to effect alterations and do other work necessary to make good such areas to

satisfaction of consultant.

.6 Temporarily seal openings in existing floor assemblies and vertical fire separations necessitated by installation of equipment and systems or construction with fire barrier materials such as mineral wool or other noncombustible insulation.

.7 If during alteration work existing asbestos material, other than known asbestos, is discovered (e.g. fireproofing, acoustic or thermal insulation, tank covering), stop work in the affected area and immediately notify consultant.

.8 Fit existing air intake and exhaust openings that may be affected by dust and/or debris from the construction work with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Closely monitor filters and replace them when necessary. Replace existing filters that become contaminated with dust and/or debris from construction work with new filters.

.9 If dust and debris from renovation work does penetrate the building and/or its air distribution systems, clean the affected areas and/or systems.

.10 Remove temporary filters on completion of the renovation work.

3.6 INSPECTION AND RE-CERTIFICATION

.1 Where equipment, machine or apparatus is modified, rebuilt or rewound with any change resulting in its performance or capacity rating and characteristics ensure it is inspected and re-certified as required by authorities having jurisdiction.

.2 Provide and affix a nameplate giving the name of the person or firm making the change and the resulting changes in performance or capacity to the equipment, machine or apparatus adjacent to the original nameplate. Where the original nameplate is removed, add the original manufacturer's name and original identifying data, such as serial numbers to the nameplate.

.3 Refer to rules 2-100 and 2-102 of the Ontario Electrical Safety Code.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 01 01.

1.2 COMMON WORK RESULTS

.1 Section 23 05 00 applies to and governs all work of Division 23.

1.3 REFERENCE STANDARDS

.1 Provide Work in accordance with requirements of Regulatory Agencies and conform to:

.1 Local and district by-laws, regulations and published engineering standards.

.2 the Ontario Building Code as amended,

.3 the Ontario Gas Utilization Code as amended

.4 Regulations for Construction Projects under The Occupational Health and Safety Act.

.5 Fire Code made under the Fire Marshal's Act.

.2 CSA Group (CSA):

.1 CAN/CSA-B149-15: Natural Gas & Propane Installation Code.

.2 CAN/CSA B139-04, Installation Code for Oil Burning Equipment.

.3 CSA B242 Groove and Shoulder Type: Mechanical Pipe Couplings.

.4 CSA B51, Boiler, Pressure Vessel and Pressure Piping Code.

.3 National Research Council Canada:

.1 National Building Code of Canada and Supplements to National Building Code of Canada

.2 National Fire Code of Canada.

.3 Canadian Plumbing Code.

.4 American Society for Testing and Materials (ASTM):

.1 ASTM E1 - Specification for ASTM Thermometers.

.2 ASTM E77 - Inspection and Verification of Thermometers.

.5 American Society of Mechanical Engineers (ASME)

.1 ASME B31.1 – ASME Code for Power Piping

.2 ASME B31.9 – ASME Code for Building Services Piping.

.6 National Electrical Manufacturers Association (NEMA):

.1 MG 1 - Motors and Generators.

.7 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.

.8 Provide work where indicated in conformance with guide Specification of the Victaulic System for Building Services, G-100.

1.4 1.4 QUALIFICATIONS

.1 Motor manufacturer: Company specializing in manufacture of electric motors for HVAC use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience.

.2 Firestop Sealant Manufacturer: Company specializing in manufacture of sealants with minimum three years' documented product development, testing, and manufacturing experience.

.3 Firestop components and assemblies shall be ULC listed and tested in accordance with ULC S115 Standard Method of Fire Test for Firestop Systems.

1.5 SUBMITTALS

.1 Submit shop drawings in accordance with Section 23 01 01.

1.6 DELIVERY, STORAGE, AND HANDLING

.1 Transport, handle, store, and protect products as per Section 23 01 01. Refer to Division 01 requirements as well.

.2 Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

2 PRODUCTS

2.1 PIPING SPECIALTIES

.1 Provide cast brass, pressure, copper to copper unions with seamless copper tubing smaller than 3" (75 mm).

.2 Provide cast brass flanges with seamless copper tubing, type L for tubing 3" (75 mm) and larger.

.3 Provide dart type, 125 lb. (860 kPa) black malleable iron unions used with steel pipe 2-1/2" (65 mm) and smaller.

.4 Provide RFSO, 150 lb. carbon steel flanges with 1/16" (4 mm) raised face steel pipe for carbon steel piping larger than 2-1/2" (65 mm).

.5 Provide 1/16" (4 mm) Cranite ring type gaskets for RFSO flanges.

.6 Line size piping specialties including backflow preventers, strainers, valves etc.

unless indicated otherwise on drawings.

2.2 ACCESS DOORS

.1 Standard Universal Flush

.1 Material: Up to 16" x 16" (400x400) 16 Gauge mounting frame, over 16" x 16" (400x400) 14 gauge door, 16 gauge mounting frame.

.2 Hinge: Continuous, concealed.

.3 Latch: Stainless steel screwdriver operated cam latch

.4 Finish: Steel: 5-stage iron phosphate preparation with prime coat of white, Alkyd Baking Enamel or stainless steel type 304, No. 4 satin polish.

.5 Manufacturers:

.1 Acudoor UF-500

.2 CEB

.3 MIFAB

.4 Cendrex Contour

.2 Recessed Access Door

.1 Material: Steel or stainless steel, 22 gauge door, 22 gauge mounting frame. Door -recessed 5/8"

.2 Hinge: Continuous, concealed.

.3 Latch: Stainless steel screwdriver operated cam latch

.4 Finish: Satin coat steel

.5 Manufacturers:

.1 Acudoor UF-5015

.2 CEB

.3 MIFAB

.4 Cendrex Contour

.3 Fire Rated

.1 Access doors in fire separations or fire rated assemblies: ULC labelled. Refer to Architectural drawings for ratings of fire separations and assemblies. Minimum 12 gauge.

.2 Hinge: Continuous, concealed.

.3 Latch: Stainless steel screwdriver operated cam latch

.4 Finish: Steel: 5-stage iron phosphate preparation with prime coat of white, Alkyd Baking Enamel or stainless steel type 304, No. 4 satin polish.

.5 Manufacturers:

.1 Acudoor

.2 CEB

.3 MIFAB

.4 Cendrex Contour

2.3 SLEEVES

.1 Materials: minimum schedule 20 galvanized steel or cast iron.

2.4 FLASHINGS AND COUNTERFLASHINGS

.1 Provide Thaler or equivalent mechanical/electrical flashings as recommended for specific purpose.

.2 Stainless steel flashing sleeves, integral deck flange and EPDM seal.

3 EXECUTION

3.1 INSPECTION

.1 Inspect installed work of other trades and verify that such work is complete to point where work under this Division may properly commence.

.2 Verify that work of this Division may be executed in accordance with pertinent codes and regulations, specifications, drawings, and referenced standards.

.3 Review drawings and verify dimensions at the site. Report discrepancies immediately to Consultant before proceeding with any construction work or shop drawings.

3.2 PREPARATION

.1 Existing services and equipment shall be relocated or removed to suit new construction and renovation work.

.2 Services that are no longer required shall be removed or cut back and capped to the satisfaction of Consultant.

.3 Obtain written authorization from Consultant for renovation work that is not specifically indicated.

.4 Where modifications or connections to existing systems require shutdown of the system the Contractor shall submit a request for system shutdown describing the system or part to be shutdown, the duration of the shutdown, the work planned and steps to be taken to reinstate the system to full operation. The request shall be submitted in the format stipulated by the Owner.

.5 All work required to prepare systems for shutdown and/or re-instatement, such as draining, chemical treatments, and re-filling shall be included in this Bid Price.

3.3 ELECTRICAL COMPONENTS AND WIRING

.1 Conform to requirements of Division 26 for all wiring included in Division 23. Includes pre-wired equipment provided by Sections under Division 23.

.2 Ensure that all pre-wired electrical equipment is CSA approved. Arrange and pay for special approval where this is not possible.

.3 Coordinate all wiring requirements with other Divisions. Line voltage wiring from power distribution panels to starters and from starters to motors will be provided under Division 26. All field wiring for equipment shall be included under Division 23, unless specifically called for under Division 25.

3.4 SUPPORT AND ATTACHMENT

.1 Support and attach piping, ductwork fixtures and equipment from load bearing structures such as beams, joists, reinforced concrete slabs and concrete block walls, and do not support from or attach to steel roof deck and/or wall or ceiling finishes.

.2 Anchor roof mounted mechanical equipment and services to the roof structure to resist both lateral and uplift wind forces in accordance with requirements of the Ontario Building Code.

3.5 PAINTING

.1 Repair minor damage to finish of equipment with standard factory applied baked enamel finish under the appropriate Sections of this division. Replace entirely, items suffering major damage to finish if too extensive to be repaired in the opinion of the Consultant.

.2 Apply at least one coat of corrosion resistant primer paint to supports, and equipment fabricated from ferrous metals.

3.6 DISSIMILAR METALS

.1 Separate dissimilar metals in order to prevent galvanic corrosion.

.2 Provide gaskets or shims of approved materials to avoid electrolytic action.

.3 Use dielectric unions and/or flanges where piping of dissimilar metals are connected.

3.7 EQUIPMENT BASES AND CURBS

.1 Provide inserts, anchor bolts and other fasteners required, for floor mounted tanks, heaters, pumps, air handlers, boilers, etc. Anchor equipment to pads using 8" (200 mm) cast-in-place anchor bolts.

3.8 SERVICE CONNECTIONS

.1 Include in Bid Price all amounts required by utilities for service connections and /or modifications to service connection. Ensure amounts include fees, assessments, charges, etc., required in relation to service connection.

3.9 FIELD QUALITY CONTROL

.1 Temporary and Trial Usage

.1 Do not construe such usage as evidence of acceptance of work by Owner.

.2 Repair damage to work tested, resulting from such trial usage, by this Contractor at no cost to Owner.

.2 Systems Verification:

.1 Verify the correct installation and proper operation of equipment and systems installed. Adjust and balance each system as necessary to achieve optimum operation of each system.

.2 Co-operate with the TAB agency as follows:

.1 provide assistance when and as requested,

.2 co-ordinate completion of work systematically to permit orderly verification and adherence to schedules,

.3 provide additional necessary flow balancing devices as directed by agency,

.4 notify TAB Agency of tests being conducted.

3.10 ADJUST AND CLEAN

.1 Clean equipment and fixtures, lubricate mechanical equipment installed under this Division and leave items in perfect order ready for operation.

.2 Test and adjust control devices, instrumentation, relief valves, dampers, etc., installed in this Division after cleaning of systems and leave in perfect order ready for operation.

.3 Remove from the premises upon completion of work of this division, debris, surplus, and waste materials resulting from operations.

3.11 INSTALLATION OF ACCESS DOORS

.1 Supply access doors for access to equipment requiring service, lubrication or adjustment and all concealed valves, cleanouts, trap primers, control and volume dampers, and other such equipment.

.2 Turn over access doors to the appropriate general trade for installation under other Sections.

.3 Refer to architectural drawings for ratings of fire separations and assemblies. install fire rated access doors in fire rated partitions, walls, and ceilings.

.4 Access doors in ceilings shall be minimum 24" x 24" (600mm x 600mm), unless otherwise approved by the Consultant.

.5 Provide concealed access doors in GWB ceilings and coordinate in-fill with general trades.

END OF SECTION

1. GENERAL

1.1 SUMMARY

.1 Section Includes:

.1 Electrical motors, drives and guards for mechanical equipment and systems.

.2 Supplier and installer responsibility indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.

.3 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems specified in Division 22 and 23. Refer to Division 26 for quality of materials and workmanship.

.2 Related Requirements

.1 Section 23 01 01.

1.2 REFERENCE STANDARDS

.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)

.1 ASHRAE 90.1-13, Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 Electrical Equipment Manufacturers' Association Council (EEMAC)

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

.1 Safety Data Sheets (SDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.1 Submit Workplace Hazardous Materials Information System (WHMIS) Safety Data Sheets (SDS) in accordance with Section 01 33 00 - Submittal Procedures.

.3 Quality Control: in accordance with Section 01 45 00 - Quality Control.

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Instructions: submit manufacturer's installation instructions.

.4 Closeout Submittals

.1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

.1 Regulatory Requirements: work to be performed in compliance with applicable Provincial /Territorial regulations.

.2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

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

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

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

2. PRODUCTS

2.1 GENERAL

.1 Motors: high efficiency, in accordance with local Hydro company standards and to ASHRAE 90.1.

.2 Provide internal wiring, relays, contactors, switches, transformers, motor starters, and controls necessary for the intended operation, furnished with terminals and external controls suitable for connection to power source at a single easily accessed location for items that are supplied with motors and/or electrical or electronic components under this division.

2.2 MOTORS

.1 Provide motors for mechanical equipment as specified.

.2 Motors under 1/2 HP: speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated. Provide continuously rated squirrel cage induction type with capacitor start, EEMAC `N' starting characteristics and a minimum of Class `A' insulation.

.3 Motors 1/2 HP and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40 °C, 3 phase, unless otherwise indicated. Provide continuously rated squirrel cage induction type with EEMAC `B' starting characteristics and a minimum of Class `B' insulation.

.4 Do not provide motors with class F or H insulation for TENV enclosure ratings. Do not provide class H insulation motors for all other enclosure ratings.

.5 If providing a motor with an insulation class that increases the temperature rating of the wiring, bear the associated cost for the electrical changes at no additional cost to the project.

2.3 TEMPORARY MOTORS

.1 If delivery of specified motor will delay completion or commissioning work, install motor approved by Consultant for temporary use. Work will only be accepted when specified motor is installed.

2.4 BELT DRIVES

.1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.

.2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise indicated.

.3 For motors under 10 HP: standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.

.4 For motors 10 HP and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.

.5 Correct size of sheave determined during commissioning.

.6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.

.7 Motor slide rail adjustment plates to allow for centre line adjustment.

.8 Supply one set of spare belts for each set installed in accordance with Section 01 78 00 - Closeout Submittals.

2.5 DRIVE GUARDS

.1 Provide guards for unprotected drives.

.2 Guards for belt drives.

.1 Expanded metal screen welded to steel frame.

.2 Minimum 1.2 mm thick sheet metal tops and bottoms.

.3 [38] mm dia holes on both shaft centres for insertion of tachometer.

.4 Removable for servicing.

.3 Provide means to permit lubrication and use of test instruments with guards in place.

.4 Install belt guards to allow movement of motors for adjusting belt tension.

.5 Guard for flexible coupling:

.1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.

.2 Securely fasten in place.

.3 Removable for servicing.

.6 Unprotected fan inlets or outlets:

.1 Wire or expanded metal screen, galvanized, 19 mm mesh.

.2 Net free area of guard: not less than 80% of fan openings.

.3 Securely fasten in place.

.4 Removable for servicing.

2.6 VARIABLE FREQUENCY DRIVES

.1 General:

.1 Provide electronic pulse width modulating design for speed control of NEMA Design B induction motors.

.2 CSA listed.

.3 Mounted in CSA Standard C22.1 Type 1 enclosure,

.4 Provide door or frame mounted interlocked disconnect switch, lockable, to disconnect input power from the drive and internally mounted options.

.5 Provide full speed electronic bypass with magnetic starter.

.6 Operating voltage:

.1 +30%, -35% of nominal supply voltage range to drive,

.2 Protection circuitry to lock-in drive or bypass over this voltage tolerance,

.7 Environmental operating conditions:

.1 Temperature: 0 - 40°C (32 – 104°F) continuous.

.2 Altitude: 0 - 1000 m (0 - 3300 ft) above sea level.

.3 Humidity: up to 95% relative humidity non-condensing.

.8 Cooling fans: designed for easy replacement, and without requiring removing the VFD from the wall or removal of circuit boards,

.1 operate only when required; VFD cycles the cooling fans on and off as required.

.9 Seismic rating:

.1 Drive and bypass package seismic certified.

.2 Seismic importance factor of 1.5.

.3 Rating certification based upon actual shake table test data as defined by ICC AC-156.

.10 Manufacturer:

.1 Third party and “brand-labeled” are not acceptable.

.2 Standard of Acceptance:

.1 ABB
.2 Danfoss
.3 Siemens
.4 Cutler Hammer
.5 Allen Bradley
.6 Baldor
.7 Schneider Electric

.2 Performance requirements:

.1 Capable of starting into a coasting load (forward or reverse) up to full speed and accelerate. Decelerate to set point without tripping or component damage (flying start),

.2 Automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip.

.3 programmable number of restart attempts, trial time, and time between attempts,

.4 Drive overload rating:

.1 110% of its normal duty current rating for 1 minute every 10 minutes,

.2 130% overload for 2 seconds

.5 Maximum input current rating: 3% greater than the output current rating,

.6 Show input and output current ratings on nameplate.

.7 Include coordinated AC transient surge protection system consisting of 4-120 joule rated MOV's (phase to phase and phase to ground), capacitor clamp, and 5% impedance reactors.

.8 Provide mis-wiring detection and alarm on drives up to 75 HP.

.3 Power conditioning:

.1 Built-in input impedance reactors to reduce the total harmonic current demand (TDD) to a maximum of 45% TDD measured at the drive line terminals composed of:

.1 Dual (positive and negative DC bus) Link, or

.2 5% AC link, or

.3 Single DC Link and an AC link.

.2 Provide input transient protection, RFI filter and output LC load reactor for drives with motor.

.4 Equipment and motor protection:

.1 Provide under and over voltage protection, phase loss protection and phase unbalance protection.

.2 Provide current limiting device adjustable from 70% to 100% of rated motor current.

.3 Provide ground fault protection.

.4 Provide inherent short circuit protection for line to line and line to ground faults giving safe shut down without damage to power circuit devices.

.5 Provide instantaneous electronic over current protection.

.6 Provide internal over-temperature protection and motor stall protection.

.5 Operator Interface Keypad and Display:

.1 Same interface across motor rating range.

.2 Digital display with keypad.

.3 “Hand-Off-Auto” selections and manual speed control.

.4 Fault reset and "Help" buttons.

.5 Loss-of-load alarm.

.6 Keypad:

.1 Backlit LCD display,

.2 Complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable),

.7 Help button access to "on-line" assistance for programming and troubleshooting, including 14 programming assistants:

.1 Start-up

.2 Parameter

.3 PID

.4 Reference

.5 I/O

.6 Serial communications

.7 Option module

.8 Panel display

.9 Low noise set-up

.10 Maintenance

.11 Troubleshooting

.12 Drive optimizer

.8 Operating values displayed in engineering (user) units, minimum of three values displayed at one time from the following:

.1 Output Frequency

.2 Motor Speed (RPM, %, or Engineering units)

.3 Motor Current

.4 Motor Torque

.5 Motor Power (kW)

.6 DC Bus Voltage

.7 Output Voltage

.6 Control Functions

.1 Provide three (3) programmable unrestricted critical frequency lockout ranges to prevent VFD from operating the load continuously at an unstable speed.

.2 Provide two (2) PID Set point controllers allowing pressure or flow signals to be connected directly to the VFD:

.1 VFD microprocessor for the closed-loop control.

.2 250 mA of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others,

.3 Adjustable PID set point from keypad, analog inputs, or BAS.

.4 Two (2) independent parameter sets for the PID controller with switching between the two via a discrete input, serial communications or from the keypad.

.3 Independent second PID loop able to utilize the second analog input and modulate one of the analog outputs to maintain the set point of an independent process (ie. valves, dampers, etc.),

.4 Ensure set points, process variables, etc. to be accessible from the serial communication network,

.5 Provide programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal.,

.6 Provide "bumpless transfer" of speed reference when switching between "Hand" and "Auto" modes.

.7 Programmable loss-of-load (broken belt / broken coupling) Form-C relay output and over the serial communications bus, with programmable time delay for motor start-up,

.8 Programmable underload and overload curve functions to allow user defined indications of broken belt or mechanical failure / jam condition causing motor overload/

.9 Loss of input reference (4-20mA or 2-10V); user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the AFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user with alarm output to a Form-C relay output and over the serial communication bus.

.10 Provide password protected parameter settings.

.7 Input Connections:

.1 Two (2) programmable inputs for 0-20ma, 4-20 ma, or 0-10VDC.

.2 Six (6) programmable inputs for interfacing with external devices programmable to initiate upon an application or removal of 24VDC or 24VAC.

.3 Run permissive circuit for damper or valve control: when the damper or valve is fully open, a damper normally open dry contact (end-switch) closes, and the closed end-switch is wired to a digital input and allows VFD motor operation.

.4 Safety interlock circuits:

.1 Two (2) separate safety interlock inputs.

.2 When either safety is opened, the motor coasts to stop and associated damper/valve is commanded to close.

.3 Keypad displays "start enable 1 (or 2) missing" and the safety input status transmitted over the BAS.

.8 Output Connections:

.1 Two (2) programmable outputs for 0-20ma, 4-20 ma, or 0-10VDC; each programmable as a minimum to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, Active Feedback.

.2 Three (3) programmable, digital Form-C relay outputs

.1 Programmable on and off delay times and adjustable hysteresis.

.2 Rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC.

.3 Maximum voltage 300 VDC and 250 VAC with continuous current rating of 2 amps RMS.

.4 True Form-C type contacts; open collector outputs are not acceptable.

.3 Run command circuit for damper or valve control:

.1 Functions regardless of the source of a run command (keypad, input contact closure, timeclock control, or serial communications),

.2 Form-C relay closure that will signal the damper to open (VFD motor does not operate),

.9 Programmable Time Delay functions:

.1 Start delay and a keypad indication that this time delay is active,

.2 Form C relay output provides a contact closure to signal the VAV boxes open; this will allow VAV boxes to be driven open before the motor operates,

.3 Field programmable from 0 - 120 seconds,

.4 Start delay active regardless of the start command source (keypad command, input contact closure, time-clock control, or BAS), and when switching from drive to bypass.

.10 .10 Speed Control functions:

.1 Seven (7) programmable preset speeds,

.2 Two (2) independently adjustable acceleration and deceleration ramps with 1 - 1800 seconds adjustable time ramps.

.3 Minimum speed setting adjustable from 0 to 70%,

.4 Maximum speed setting adjustable from 50 to 110%,

.5 Rotating motor restart routine to match frequency and actual speed before accelerating to set speed.

.6 Acceleration/deceleration ramp adjustable from 10 to 100 seconds for 0 to 100% speed,

.7 Motor flux optimization circuit to automatically reduce applied motor voltage to the motor to optimize energy consumption and reduce audible motor noise; selectable software for optimization of motor noise, energy consumption, and motor speed control.

.8 Carrier frequency control circuit to reduce the carrier frequency based on VFD temperature that allows higher carrier frequency settings without derating the VFD.

.11 Programming:

.1 Built-in time clock in the keypad with battery back up of 10 years minimum life span.

.2 Time clock date and time stamp faults and records operating parameters at the time of fault. On battery failure, automatically reverts to hours of operation since initial power up.

.3 Time clock programmable to control start/stop functions, constant speeds, PID parameter sets and output Form-C relays.

.4 Discrete input that allows time clock override (when in the off mode) for a programmable time frame.

.5 Four (4) separate, independent timer functions that have both weekday and weekend settings.

.6 Utilize pre-programmed application macro's specifically designed to facilitate start-up.

.7 Application macros provide one command to reprogram parameters and customer interfaces for a particular application to reduce programming time.

.8 Two user macros to allow the end-user to create and save custom settings.

.12 Fireman’s Override Input:

.1 On receipt of a contact closure from the fire / smoke control station, the AFD operates in one of two selectable modes:

.1 Programmed predetermined fixed speed ranging from -500Hz (reverse) to 500Hz (forward).

.2 Operate in a specific fireman's override PID algorithm that automatically adjusts motor speed based on override set point and feedback; setpoint adjusted over the BAS

.2 Operating mode overrides other inputs (analog/digital, serial communication, and all keypad commands), except safety run interlocks, and force the motor to run in one of the two modes above.

.3 "Override Mode" displayed on the keypad when override is active.

.4 VFD resumes normal operation, without the need to cycle the normal discrete input run command when override is removed.

.13 BAS Integration:

.1 EIA-485 port as standard for the following resident protocols:

.1 BACnet MS/TP

.2 BACnet IP

.3 LonWorks

.4 Modbus

.5 Johnson Controls current protocol.

.2 Do not use third party gateways and multiplexers.

.3 Protocols "certified" by the governing authority including:

.1 BTL Listing for BACnet,

.2 Lonmark functional profile 6010, for both mandatory and optional items.

.4 Use of non-certified protocols is not permitted.

.5 Serial communication capabilities:

.1 Run-stop control.

.2 Speed set adjustment.

.3 PID control adjustments.

.4 Current limit.

.5 Acceleration/deceleration time adjustments.

.6 Lock and unlock the keypad.

.7 Allow the BAS to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature.

.8 BAS capable of monitoring the AFD relay output status, discrete input status, and all analog input and analog output values.

.9 Diagnostic warning and fault information.

.10 Remote fault reset.

.6 Digital and analog output control:

.1 BAS control digital and analog outputs via the serial interface; this control is independent of VFD function.

.2 Analog outputs may be used for modulating chilled water valves or cooling tower bypass valves.

.3 Form-C relay outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation.

.4 Digital inputs capable of being monitored by the BAS system, including monitoring of which safeties are open.

.7 Independent PID loop:

.1 Useable for cooling tower bypass value control, chilled water value / hot water valve control, etc.

.2 Both the VFD PID control loop and the independent PID control loop continue functioning even if the serial communications connection is lost.

.3 As default, the VFD keeps the last good set point command and last good DO & AO commands in memory in the event the serial communications connection is lost and continue controlling the process.

2.7 VFD TO MOTOR WIRING

.1 Provide liquid tight, flexible metal conduit and cable to be specifically manufactured for this duty between VFD and motor.

.2 Voltage rating: nominal 1000 V, and voltage spikes to 2000 V,

.3 3 phase and 3 ground conductors.

.1 NEXANS - Drive Rx - Variable speed drive cable

.2 LAPP USA - OLFLEX® VFD SLIM; Severe duty power cable for AFD drives

.3 ShawCor - Shawflex VFD cable

.4 Rockbestos-Suprenant Cable - EXANE - VFD sheathed armoured power cable.

3. EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Fasten securely in place.

.2 Make removable for servicing, easily returned into, and positively in position.

3.3 VARIABLE SPEED DRIVES

.1 Where a separate disconnect is installed between the drive and the controlled equipment, provide interlock wiring between disconnect status contact switch, and VFD, to prevent drive from operating if disconnect switch is open.

.2 Conduct impact vibration test to determine first natural harmonic of driven equipment, and program VFD skip speed function to prevent operation at this speed.

.1 nominal skip speed range equal to ± 5% of measured harmonic frequency, or as determined on site.

.3 Provide power wiring, conduit and branch circuit protection to line side of VFD, selected for drive input current.

.4 Do not start-up drives until local area has been brought to final clean, floors are sealed, and any drywall in the same space is sanded and painted.

.5 Start-Up and Testing

.1 Do not use VFD’s for equipment which are used for temporary construction heat prior to final construction cleaning of the space in which the drives are located.

.2 If equipment is to be used prior to final construction clean, provide temporary magnetic starters, or, provide enclosures around the drives and pressurized the enclosures with a source of clean air.

.3 Provide the services of a certified factory authorized representative for the start-up of each drive.

.4 Complete and submit a certified start-up form filled out for each drive.

.6 Demonstration and Training

.1 Provide the services of a factory trained manufacturer's representative to provide training to Owners staff. Include in training:

.1 Installation instructions.

.2 Programming.

.3 Operation.

.4 At-site servicing.

.5 Replacement of keypad controller

.6 Manual and automatic operation of bypass, if applicable.

.7 Serial communications

.8 Fireman's smoke control override.

.2 Provide a computer based training CD or professionally generated video to the Owner at the time of project closeout for the above topics.

3.4 FIELD QUALITY CONTROL

.1 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 - 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 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.5 CLEANING

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

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1. GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 23 01 01.

1.2 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 B139-04, Installation Code for Oil Burning Equipment.

.3 Green Seal Environmental Standards (GSES)

.1 Standard GS-11-2008, 2nd Edition, Environmental Standard for Paints and Coatings.

.4 National Research Council Canada (NRC)

.1 National Fire Code of Canada 2015 (NFC).

.5 American Society of Mechanical Engineers (ASME)

.1 ASME B31.1 – ASME Code for Power Piping

.2 ASME B31.9 – ASME Code for Building Services Piping.

1.3 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, specifications and datasheets for piping and equipment and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 QUALITY ASSURANCE

.1 Sustainability Standards Certification:

.1 Low-Emitting Materials: provide listing of sealants and coatings used in building, comply with VOC and chemical component limits or restriction requirements.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

2. PRODUCTS

2.1 MATERIAL

.1 Paint: zinc-rich to CAN/CGSB-1.181.

.1 Primers, paints, and coatings: Provide in accordance with manufacturer's recommendations for surface conditions to Standard GS-11.

.2 Primer: maximum VOC limit 250 g/L

.3 Paints: maximum VOC limit 150 g/L

.4 Adhesives for Mechanical Identification: maximum VOC emission of 70g/L

.5 Sealants for service penetrations: maximum VOC emission of 650g/L clear and 350 g/L pigmented

.6 Sealants for Firestopping: max. VOC emission of 650g/L clear and 350 g/L pigmented

.7 Acrylic Sealant for supports and anchors: maximum VOC emission of 250g/L

.8 Insulation Vapour Barrier Lap Adhesive: maximum VOC emission of 80g/L

.9 Insulation Joint Sealer: maximum VOC emission of 250g/L

.10 Insulation Vapour Barrier Mastic: maximum VOC emission of 400g/L

.11 Flame Retardant Adhesive: maximum VOC emission of 650g/L clear and 350 g/L pigmented.

.2 Sealants: in accordance with Section 07 92 00 - Joint Sealants.

.1 Sealants: maximum VOC limit to GSES GS-36.

.3 Sealants: maximum VOC limit to GSES GS-36.

.4 Adhesives: maximum VOC limit to GSES GS-36.

.5 Fire Stopping: in accordance with Section 07 84 00 - Fire Stopping.

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 double swing joints 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, maintenance and as recommended by manufacturer and National Fire Code of Canada and CAN/CSA B139.

.2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer, CAN/CSA B139, and as indicated without interrupting operation of other system, equipment, 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 to CAN/CSA B139 for oil piping and at high points in piping systems.

.2 Install isolating valve at each automatic air valve.

.3 Install drain piping to approved location and terminate where discharge is visible.

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 CAN/CSA B139, ASME B31.1 or ASME B31.9 as applicable.

.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.

.2 Ensure openings are cut true, beveled and filed smooth.

.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 Install piping, wherever possible, in partitions and above ceiling. Do not install piping in outside walls unless so shown on drawings. Wrap uninsulated piping in masonry walls with building paper.

.10 Slope piping, except where indicated, in direction of flow for positive drainage and venting.

.11 Install, except where indicated, to permit separate thermal insulation of each pipe.

.12 Group piping wherever possible and as indicated.

.13 Ream pipes, remove scale and other foreign material before assembly.

.14 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.

.15 Provide for thermal expansion as indicated.

.16 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 Install globe valves in bypass around control valves.

.6 Use gate, ball or butterfly valves at branch take-offs for isolating purposes except where specified.

.7 Install butterfly valves on chilled water and related condenser water systems only.

.8 Install butterfly valves between weld neck flanges to ensure full compression of liner.

.9 Install plug cocks or ball valves for glycol service.

.10 Use chain operators on valves NPS 2 1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.

.17 Check Valves:

.1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.

.2 Install swing check valves in horizontal lines on discharge of pumps and as indicated.

.18 Arrange all take-offs from mains to allow for expansion and contraction of pipes. Take hot water branches serving down feed risers from lower sides or bottom of mains and grade down slightly to risers. Take branches which serve units above the mains from the top or sides of mains.

3.8 PIPING JOINTS

.1 Make joints in piping installed under this Division using persons familiar with the particular materials being used and in accordance with CSA B51 and CSA B52, manufacturer's instructions, and as specified herein.

.2 Use silver solder or Silfos for joining copper tubing 4" (100 mm) and larger in size.

.3 Carefully ream joints in threaded pipe and paint with approved graphite type joint sealer on male connections only. Make connections with proper wrench to suit pipe size. Where leaks occur, disassemble the joint and correct if possible or replace. Do not over-tightening, caulk or peen leaking joints.

.4 Victaulic Grooved Piping Method:

.1 Make joints in grooved piping with couplings and gaskets in accordance with Victaulic Company of Canada Ltd, General Catalogue G-100, latest edition. Cut or roll grooves using tools specifically designed for that purpose.

.2 Use Zero-flex or Rigidlok couplings in locations where rigidity is required, such as in mechanical rooms on coils, headers and pumps.

.3 Vic-Boltless couplings may be used.

.5 Install unions or welding flanges at connections to valves, etc. to facilitate removal.

3.9 SLEEVES AND CURBS

.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 ferrous sleeve.

.7 Provide watertight concrete curb 4" (100 mm) high around mechanical services (pipes, ducts, conduits) which rise through mechanical (service) room floors. Provide minimum 4" (100 mm) clearance between openings for services within curbs.

.8 For pipes passing through roofs, use cast iron sleeves with caulking recess and flashing clamp device. Anchor sleeves in roof construction, caulk between sleeve recess and pipe, fasten roof flashing to clamp device, make water-tight durable joint. Co-ordinate with roofing Section.

3.10 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.

.2 Where sleeve extends above finished floor, escutcheon or plates shall clear sleeve extension.

.4 Secure to pipe or finished surface, but not insulation.

3.11 FLASHINGS

.1 Provide flashing at each point where piping passes through the roof.

.2 Coordinate this work with the roofing Trades to ensure a satisfactory installation and to avoid delays.

3.12 PREPARATION FOR FIRE STOPPING

.1 Coordinate the installation of fire stopping around pipes, insulation and adjacent fire separation in accordance with Section 07 84 00 - Fire Stopping.

.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.

3.13 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.

.4 Remove, clean and replace all strainers in systems after flushing.

.5 Thoroughly clean and lubricate HVAC equipment and leave all items in perfect order ready for operation.

3.14 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

.1 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.

.2 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.

.3 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.

.4 Repair leaks exposed during testing and retest. If defects in pipe or fittings are discovered in the system, removed and replace.

.5 Pay costs for repairs or replacement, retesting, and making good. Consultant to determine whether repair or replacement is appropriate.

.6 Insulate or conceal work only after approval and certification of tests by Consultant.

.7 Prior to tests, isolate equipment or other parts which are not designed to withstand test pressures.

.8 Test piping at the completion of roughing-in, before connecting to existing systems, and prior to concealment, insulation or covering of piping.

.9 Make tests, that are required by any authority having jurisdiction, in the presence of the authority's authorized inspector and shall be certified by him.

.10 Conduct tests in the presence of:

.1 Authorized inspector(s) for authorities having jurisdiction.

.2 The Commissioning Agent

.3 The Owner's Representative

.4 The Consultant

.11 Give notification at least 48 hours in advance of tests being conducted, to persons required to be present.

.12 Certify tests not required by authorities having jurisdiction.

3.15 EQUIPMENT TESTING AND INSPECTION

.1 Test operation of equipment installed under this Division according to instructions in appropriate articles of this Division. Make any required adjustments or replacements to ensure equipment is operating as intended. Retest equipment requiring adjustment or replacement.

.2 Pay fuel consumption charges for equipment under testing and during commissioning.

.3 Conduct tests before application of external insulation and before concealment of piping or ductwork.

.4 Arrange and pay for inspections by authorities as required by code and complete any changes or alterations required by such inspections.

.5 Conduct tests in the presence of:

.1 Authorized inspector(s) for authorities having jurisdiction.

.2 The Commissioning Agent.

.3 The Consultant.

.4 The Owner's Representative.

.6 Give notification at least 48 hours in advance of tests being conducted, to persons required to be present.

3.16 EXISTING SYSTEMS

.1 Connect into existing piping systems at times approved Consultant.

.2 Request written approval by Consultant ten (10) days minimum, prior to commencement of work.

.3 Be responsible for repair of damage to existing plant by this work.

3.17 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

1. GENERAL

1.1 GENERAL REQUIREMENTS

.1 Refer to Section 23 01 01.

1.1 REFERENCE STANDARDS

.1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)

.1 ANSI/ASME B31.1-2007, Power Piping.

.2 ANSI/ASME B31.3-2006, Process Piping.

.3 ANSI/ASME Boiler and Pressure Vessel Code-2007:

.1 BPVC 2007 Section I: Power Boilers.

.2 BPVC 2007 Section V: Non-destructive Examination.

.3 BPVC 2007 Section IX: Welding and Brazing Qualifications.

.2 American National Standards Institute/American Water Works Association (ANSI/AWWA)

.1 ANSI/AWWA C206-03, Field Welding of Steel Water Pipe.

.3 American Welding Society (AWS)

.1 AWS C1.1M/C1.1-2000(R2006), Recommended Practices for Resistance Welding.

.2 AWS Z49.1-2005, Safety in Welding, Cutting and Allied Process.

.3 AWS W1-2000, Welding Inspection Handbook..

.4 CSA Group (CSA)

.1 CSA W47.2-M1987(R2008), Certification of Companies for Fusion Welding of Aluminum.

.2 CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding.

.3 CSA B51-03(R2007), Boiler, Pressure Vessel and Pressure Piping Code.

.4 CSA-W117.2-2006, Safety in Welding, Cutting and Allied Processes.

.5 CSA W178.1-2008, Certification of Welding Inspection Organizations.

.6 CSA W178.2-2008, Certification of Welding Inspectors.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 QUALITY ASSURANCE

.1 Qualifications:

.1 Welders:

.1 Ensure welders' welding qualifications are in accordance with CSA B51.

.2 Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.

.3 Submit welder's qualifications to Consultant.

.4 Ensure welders have identification symbol issued by authority having jurisdiction.

.5 Provide certification of companies for fusion welding of aluminum in accordance with CSA W47.2.

.2 Inspectors:

.1 Ensure welding inspectors are qualified to CSA W178.2.

.3 Certifications:

.1 Ensure registration of welding procedures in accordance with CSA B51.

.2 Have copies of welding procedures available for inspection.

.3 Conform to safety in welding, cutting and allied processes in accordance with CSA-W117.2.

1.4 DELIVERY, STORAGE AND HANDLING

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

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

2. PRODUCTS

2.1 ELECTRODES

.1 Electrodes: in accordance with CSA W48 Series.

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 QUALITY OF WORK

.1 Welding: in accordance with ANSI/ASME B31.1 or B31.3 as applicable, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1, special procedures specified elsewhere, and applicable requirements of provincial authority having jurisdiction.

3.3 INSTALLATION REQUIREMENTS

.1 Identify each weld with welder's identification symbol.

.2 Backing rings:

.1 Where used, fit to minimize gaps between ring and pipe bore.

.2 Do not install at orifice flanges.

.3 Fittings:

.1 NPS 2 and smaller: install welding type sockets.

.2 Branch connections: install welding tees or forged branch outlet fittings.

3.4 INSPECTION AND TESTS - GENERAL REQUIREMENTS

.1 Review weld quality requirements and defect limits of applicable codes and standards with Consultant before work is started.

.2 Formulate "Inspection and Test Plan" in co-operation with Consultant.

.3 Do not conceal welds until they have been inspected, tested and approved by inspector.

.4 Provide for inspector to visually inspect welds during early stages of welding procedures in accordance with Welding Inspection Handbook. Repair or replace defects as required by codes and as specified.

3.5 SPECIALIST EXAMINATIONS AND TESTS

.1 General:

.1 Perform examinations and tests by specialist qualified to CSA W178.1 and CSA W178.2 and approved by Consultant

.2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.

.3 Inspect and test 10 % of welds in accordance with "Inspection and Test Plan" by non-destructive visual examination.

.2 Hydrostatically test welds to ANSI/ASME B31.1 or B31.3 as applicable.

.3 Visual examinations: include entire circumference of weld externally and wherever possible internally.

.4 Failure of visual examinations:

.1 Upon failure of welds by visual examination, perform additional testing as directed by Consultant of total of up to 10 % of welds, selected at random by Consultant by particle tests.

.5 Provide full radiographic tests for piping systems as required by B31.1 or B31.3 as applicable.

.1 Spot radiography:

.1 Conduct spot radiographic tests of up to 10% of welds, selected at random by Consultant from welds which would be most difficult to repair in event of failure after system is operational.

.2 Radiographic film:

.1 Identify each radiographic film with date, location, name of welder, and submit to Consultant. Replace film if rejected because of poor quality.

.3 Interpretation of radiographic films:

.1 By qualified radiographer.

.4 Failure of radiographic tests:

.1 Extend tests to welds by welder responsible when those welds fails tests.

.6 Magnetic particle tests for piping systems as indicated.

3.6 DEFECTS CAUSING REJECTION

.1 As described in ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessels Code.

.2 In addition, chilled water systems:

.1 Undercutting greater than 0.8 mm adjacent to cover bead on outside of pipe.

.2 Undercutting greater than 0.8 mm adjacent to root bead on inside of pipe.

.3 Undercutting greater than 0.8 mm at combination of internal surface and external surface.

.4 Incomplete penetration and incomplete fusion greater than total length of 38 mm in 1500 mm length of weld depth of such defects being greater than 0.8 mm.

.5 Repair cracks and defects in excess of 0.8 mm in depth.

.6 Repair defects whose depth cannot be determined accurately on basis of visual examination or particle tests.

3.7 REPAIR OF WELDS WHICH FAILED TESTS

.1 Re-inspect and re-test repaired or re-worked welds at Contractor's expense.

3.8 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 RELATED REQUIREMENTS

.1 Section 23 05 00.

1.2 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B40.100-2005, Pressure Gauges and Gauge Attachments.

.2 ASME B40.200-2008, Thermometers, Direct Reading and Remote Reading.

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-14.4-M88, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.

.2 CAN/CGSB-14.5-M88, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.

.3 Efficiency Valuation Organization (EVO)

.1 International Performance Measurement and Verification Protocol (IPMVP)

.1 IPMVP 2007 Version.

.4 Green Seal Environmental Standards (GS)

.1 GS-11-11, Standard for Paints and Coatings.

.2 GS-36-11, Standard for Commercial Adhesives.

1.3 SHOP DRAWING 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 thermometers and pressure gauges and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Certificates:

.1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.4 Test and Evaluation Reports:

.1 Submit certified test reports for thermometers and pressure gauges from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:

.1 Store thermometers and pressure gauges off ground, indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect thermometers and pressure gauges from nicks, scratches, blemishes, vermin, theft and vandalism.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 GENERAL

.1 Design point to be at mid-point of scale or range.

2.2 DIRECT READING THERMOMETERS

.1 Manufacturer: Trerice Model BX91403-1/2.

.2 Other acceptable manufacturers:

.1 Weiss Model 9VS3-1/2.

.2 Winter

.3 Morrison

.4 Taylor

.3 Thermometer: 9" (230mm) scale, red appearing thermal fluid with black figures on white scale, calibrated in both degrees F and degrees C, accuracy to ASTM E77 of 2%, clear glass lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device, 3/4" (20mm) NPT brass stem.

.4 Provide thermometers with a separable well.

.5 Socket: Brass or stainless steel separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

.6 Flange: 3" (75 mm) outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

.7 to CAN/CGSB-14.4 and ASME B40.200.

.8 Resistance to shock and vibration.

2.3 REMOTE READING THERMOMETERS

.1 Manufacturer: Trerice

.2 Other acceptable manufacturers:

.1 Weiss.

.2 Winter.

.3 Morrisson.

.4 Taylor

.3 Thermometer: ASTM E1, stainless steel case, vapour or liquid actuated with brass or copper bulb, copper or bronze braided capillary, white with black markings and black pointer glass lens.

.1 Size: 2-3/8" (60 mm) diameter dial.

.2 Lens: Clear glass.

.3 Length of Capillary: Minimum 60" (1500 mm).

.4 Accuracy: 2 percent.

.5 Calibration: Both degrees F and degrees C.

.4 Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

.5 Flange: 3" (75 mm) outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

.6 To CAN/CGSB-14.5 and ASME B40.200

2.4 PRESSURE GAUGES

.1 Manufacturer: Trerice Model 600C.

.2 Other acceptable manufacturers:

.1 Weiss

.2 Winter

.3 Morrisson

.4 Taylor

.3 Gauge: 4-1/2" (115mm) diameter black cast aluminum, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background, mid-scale accuracy: 1%, scale: psi and kPa.

.4 Gauge Cock: Tee or lever handle, brass for maximum 150 psi (1034 kPa0.

.5 Needle Valve: Brass, 1/4" (6 mm) NPT for minimum 150 psi (1034 kPa).

.6 Pulsation Damper: Pressure snubber, brass with 1/4" (6 mm) connections.

.7 Syphon: Steel, Schedule 40, 1/4" (6 mm) angle or straight pattern.

.8 To ASME B40.100.

.9 Provide:

.1 Siphon for steam service.

.2 Snubber for pulsating operation.

.3 Diaphragm assembly for corrosive service.

.4 Gasketed pressure relief back with solid front.

.5 Bronze stop cock.

.6 Oil filled for high vibration applications.

2.5 TEST PLUGS

.1 Manufacturer: Pete’s Plug.

.2 Other acceptable manufacturers:

.1 Watts TP.

.3 Test Plug: 1/4" or 1/2" (6 mm or 15 mm) brass fitting and cap for receiving 1/8" (3 mm) outside diameter pressure or temperature probe with neoprene core for temperatures up to 93°C (200°F).

.4 Test Kit: Carrying case, internally padded and fitted containing one diameter pressure gauges, one gauge adapters with 1/8" (3 mm) probes, two 1" (25 mm) dial thermometers.

2.6 STATIC PRESSURE GAUGES

.1 Manufacturer: Terice

.2 Other acceptable manufacturers:

.1 Weiss.

.2 Winter.

.3 Taylor.

.3 3-1/2" (90 mm) diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.

.4 Inclined manometer, red liquid on white background with black figures, front recalibration adjustment, 3 percent of full scale accuracy.

.5 Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4" (6 mm) diameter tubing.

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 installation in accordance with manufacturer's written instructions.

- .1 Visually inspect substrate in presence of Consultant.
- .2 Inform Consultant of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 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.

3.3 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 Chillers.
- .5 Cooling towers.
- .6 DHW tanks.

.3 Install wells for balancing purposes.

.4 Use extensions where thermometers are installed through insulation.

.5 Locate test plugs adjacent thermometers and thermometer sockets.

.6 Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

.7 Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

.8 Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-3/8" (60 mm) for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

3.4 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 balancing purposes, elsewhere [as indicated].

.3 Use extensions where pressure gauges are installed through insulation.

.4 Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Provide syphon on gauges in steam systems. Extend nipples and syphons to allow clearance from insulation.

.5 Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

.6 Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.5 NAMEPLATES

.1 Install engraved lamicoid nameplates in accordance with Section 23 05 53 - Identification for HVAC Piping and Equipment, identifying medium.

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 Waste Management: separate waste materials for 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.

3.7 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by thermometer and gauge installation.

END OF SECTION

1. GENERAL

1.1 GENERAL REQUIREMENTS

.1 Refer to Section 23 01 01.

1.1 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B31.1-07, Power Piping.

.2 ASTM International (ASTM)

.1 ASTM A125-1996(2007), Standard Specification for Steel Springs, Helical, Heat-Treated.

.2 ASTM A307-07b, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.3 ASTM A563-07a, Standard Specification for Carbon and Alloy Steel Nuts.

.3 Factory Mutual (FM)

.4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)

.1 MSS SP58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.

.5 National Research Council Canada (NRC)

.1 National Plumbing Code of Canada 2015 (NPC).

.6 Underwriter's Laboratories of Canada (ULC)

1.2 SHOP DRAWING SUBMITTALS

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

.2 Product Data:

.1 Provide manufacturer's printed product literature and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit shop drawings for:

.1 Bases, hangers and supports.

.2 Connections to equipment and structure.

.3 Structural assemblies.

.4 Certificates:

.1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Manufacturers' Instructions:

.1 Provide manufacturer's installation instructions.

.1 Consultant will make available one copy of systems supplier's installation instructions.

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 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

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, 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 Performance Requirements:

.1 Design supports, platforms, catwalks, hangers to withstand seismic events as specified Section 23 05 48.

2.2 GENERAL

.1 Fabricate hangers, supports and sway braces in accordance with MSS SP58. ANSI B31.1 and

.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 or painted with zinc-rich paint after manufacture.

.2 Use electroplated or hot dipped 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.

.1 Rod: 13 mm FM approved.

.3 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, FM approved to MSS-SP58 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, FM approved to MSS SP58.

.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 FM approved.

.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 FM approved to MSS SP58.

.5 Shop and field-fabricated assemblies:

.1 Trapeze hanger assemblies: to ASME B31.1 and MSS SP 58.

.2 Steel brackets: to ASME B31.1 and MSS SP 58.

.3 Sway braces for seismic restraint systems: to Section 23 05 48.

.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 on insulated pipe to suit insulation and to avoid penetrating vapour retarders.

.8 Adjustable clevis: material to MSS SP58 FM approved clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.

.1 Ensure "U" has hole in bottom for riveting to insulation shields.

.2 Use clevis style hangers where horizontal movement is no greater than 25mm. Otherwise, provide roller-type.

.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: galvanized with formed portion plastic coated epoxy coated.

.11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP58.

2.4 RISER CLAMPS

.1 Steel or cast iron pipe: galvanized carbon steel to MSS SP58, type 42, FM approved.

.2 Copper pipe: carbon steel copper plated to MSS SP58, type 42.

.3 Bolts: to ASTM A307.

.4 Nuts: to ASTM A563.

2.5 INSULATION PROTECTION SHIELDS

.1 Insulated cold piping:

.1 64 kg/m^3 density insulation plus insulation protection shield to: MSS SP58, galvanized sheet carbon steel. Length designed for maximum 3 m span.

.2 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.

2.6 CONSTANT SUPPORT SPRING HANGERS

.1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).

.2 Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.

.3 Provide upper and lower factory set travel stops.

.4 Provide load adjustment scale for field adjustments.

.5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.

.6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.7 VARIABLE SUPPORT SPRING HANGERS

.1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.

.2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.

.3 Variable spring hanger complete with factory calibrated travel stops. Provide certificate of calibration for each hanger.

.4 Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with +/-5 % spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.

2.8 EQUIPMENT SUPPORTS

.1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings. Submit calculations with shop drawings.

2.9 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.10 PLATFORMS AND CATWALKS

.1 To Section 05 50 00 - Metal Fabrications.

2.11 HOUSE-KEEPING PADS

.1 Provide 100 mm high concrete housekeeping pads for base-mounted equipment; size pads 150 mm larger than equipment on all sides. Chamfer pad edges.

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

2.12 OTHER EQUIPMENT SUPPORTS

.1 Fabricate equipment supports from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings.

.2 Submit structural calculations with shop drawings.

3. EXERCISE

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 Vibration Control Devices:

.1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated.

.3 Clamps on riser piping:

.1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.

.2 Bolt-tightening torques to industry standards.

.3 Steel pipes: install below coupling or shear lugs welded to pipe.

.4 Cast iron pipes: install below joint.

.4 Clevis plates:

.1 Attach to concrete with 4 minimum concrete inserts, one at each corner.

.5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

.6 Use approved constant support type hangers where:

.1 Vertical movement of pipework is 13 mm or more,

.2 Transfer of load to adjacent hangers or connected equipment is not permitted.

.7 Use variable support spring hangers where:

.1 Transfer of load to adjacent piping or to connected equipment is not critical.

.2 Variation in supporting effect does not exceed 25 % of total load.

3.3 HANGER SPACING

.1 Plumbing piping: to Ontario Plumbing Code.

.2 Fire protection: to applicable fire code.

.3 Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.

.4 Copper piping: up to NPS 1/2: every 1.5 m.

.5 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.

.6 Within 300 mm of each elbow.

.7 Pipework greater than NPS 12: to MSS SP58.

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 FIELD QUALITY CONTROL

.1 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 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.8 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

1. GENERAL

1.1 SUMMARY

.1 Section Includes:

.1 Vibration isolation materials and components, seismic control measures and their installation.

.2 Related Requirements

.1 Section 23 01 01.
.2 Section 23 05 00.
.3 Section 23 05 15.
.4 Section 23 05 29.

1.2 REFERENCE STANDARDS

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

.1 Safety Data Sheets (SDS)

.2 National Fire Protection Association (NFPA)

.1 NFPA 13-2002, Standard for the Installation of Sprinkler Systems.

.3 National Research Council Canada (NRC)

.1 National Building Code of Canada 2015 (NBC).

1.3 SHOP DRAWING SUBMITTALS

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

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.1 Submit Workplace Hazardous Materials Information System (WHMIS) Safety Data Sheets (SDS) in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.1 Shop drawings: Submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.

.2 Provide separate shop drawings for each isolated system and system shop drawings complete with performance and product data.

.3 Provide detailed drawings of seismic control measures for equipment and piping.

.3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Instructions: submit manufacturer's installation instructions.

.3 Manufacturer's Field Reports: manufacturer's field reports specified.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

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

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

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

2. PRODUCTS

2.1 GENERAL

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

2.2 ELASTOMERIC PADS

.1 Type EP1 - neoprene waffle or ribbed; 9 mm minimum thick; 50 durometer; maximum loading 350 kPa.

.2 Type EP2 - rubber waffle or ribbed; 9 mm minimum thick; 30durometer natural rubber; maximum loading 415 kPa.

.3 Type EP3 - neoprene-steel-neoprene; 9 mm minimum thick neoprene bonded to 1.71 mm steel plate; 50 durometer neoprene, waffle or ribbed; holes sleeved with isolation washers; maximum loading 350 kPa.

.4 Type EP4 - rubber-steel-rubber; 9 mm minimum thick rubber bonded to 1.71 mm steel plate; 30 durometer natural rubber, waffle or ribbed; holes sleeved with isolation washers; maximum loading 415 kPa.

2.3 ELASTOMERIC MOUNTS

.1 Type M1 - colour coded; neoprene in shear; maximum durometer of 60; threaded insert and two bolt-down holes; ribbed top and bottom surfaces.

2.4 SPRINGS

.1 Design stable springs: ratio of lateral to axial stiffness is equal to or greater than 1.2 times ratio of static deflection to working height. Select for 50% travel beyond rated load. Units complete with levelling devices.

.2 Ratio of height when loaded to diameter of spring between 0.8 to 1.0.

.3 Provide cadmium plated or zinc yellow for outdoor or 100% relative humidity installations.

.4 Colour code springs.

2.5 SPRING MOUNT

.1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.

.2 Type M2 - stable open spring: support on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad.

.3 Type M3 - stable open spring: 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; levelling bolt for rigidly mounting to equipment.

.4 Type M4 - restrained stable open spring: supported on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.

.5 Type M5 - enclosed spring mounts with snubbers for isolation up to 950 kg maximum.

.6 Performance: as indicated.

2.6 HANGERS

.1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30 degrees arc without metal to metal contact.

.2 Type H1 - neoprene - in-shear, moulded with rod isolation bushing which passes through hanger box.

.3 Type H2 - stable spring, elastomeric washer, cup with moulded isolation bushing which passes through hanger box.

.4 Type H3 - stable spring, elastomeric element, cup with moulded isolation bushing which passes through hanger box.

.5 Type H4 - stable spring, elastomeric element with precompression washer and nut with deflection indicator.

.6 Performance: as indicated.

2.7 ACOUSTIC BARRIERS FOR ANCHORS AND GUIDES

.1 Acoustic barriers: between pipe and support, consisting of 25 mm minimum thick heavy duty duck and neoprene isolation material.

2.8 HORIZONTAL THRUST RESTRAINT

.1 Spring and elastomeric element housed in box frame; assembly complete with rods and angle brackets for equipment and ductwork attachment; provision for adjustment to limit maximum start and stop movement to 9 mm.

.2 Arrange restraints symmetrically on either side of unit and attach at centerline of thrust.

2.9 STRUCTURAL BASES

.1 Type B1 - Prefabricated steel base: integrally welded on sizes up to 2400 mm on smallest dimension, split for field welding on sizes over 2400 mm on smallest dimension and reinforced for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; pre-drilled holes to receive equipment anchor bolts; and complete with adjustable built-in motor slide rail where indicated.

.2 Type B2 - Steel rail base: structural steel, positioned for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; and pre-drilled holes to receive equipment anchor bolts.

.3 Bases to clear housekeeping pads by 25 mm minimum.

2.10 SEISMIC CONTROL MEASURES

.1 General:

.1 Following systems and/or equipment to remain operational during and after earthquakes:

.1 Plumbing Systems.

.2 HVAC Systems.

.2 Seismic control systems to work in every direction.

.3 Fasteners and attachment points to resist same maximum load as seismic restraint.

.4 Drilled or power driven anchors and fasteners not permitted.

.5 No equipment, equipment supports or mounts to fail before failure of structure.

.6 Supports of cast iron or threaded pipe not permitted.

.7 Seismic control measures not to interfere with integrity of fire stopping. Coordinate with Section 07 84 00 - Fire Stopping.

.2 Static equipment:

.1 Anchor equipment to equipment supports. Anchor equipment supports to structure.

.2 Suspended equipment:

.1 Use one or more of following methods depending upon site conditions or as indicated:

.3 Seismic restraints:

.1 Cushioning action gentle and steady.

.2 Never to reach metal-like stiffness.

.3 Vibration isolated equipment:

.1 Seismic control measures not to jeopardize noise and vibration isolation systems. Provide 6 to 9 mm clearance during normal operation of equipment and systems between seismic restraint and equipment.

.2 Incorporate seismic restraints into vibration isolation system to resist complete isolator unloading.

.3 As indicated.

.4 Piping systems:

.1 Fire protection systems: to NFPA 13.

.2 Piping systems: hangers longer than 305 mm; brace at each hanger.

.3 Compatible with requirements for anchoring and guiding of piping systems.

.5 Bracing methods:

.1 Approved by Consultant.

.2 Structural angles or channels.

.3 Cable restraint system incorporating grommets, shackles and other hardware to ensure alignment of restraints and to avoid bending of cables at connection points. Incorporate neoprene into cable connections to reduce shock loads.

.6 Service and utilities entrance into building: Domestic water, Ground-source geoexchange loop, fire protection water, sanitary drain.

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 Seismic control measures to meet requirements of NBC.

.2 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.

.3 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.

.4 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:

.1 Up to NPS 4: first 3 points of support. NPS 5 to NPS 8: first 4 points of support. NPS 10 and Over: first 6 points of support.

.2 First point of support: static deflection of twice deflection of isolated equipment, but not more than 50 mm.

.5 Where isolation is bolted to floor use vibration isolation rubber washers.

.6 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

3.3 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.

.2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:

.1 After delivery and storage of Products.

.2 After preparatory work is complete but before installation commences.

.3 Twice during the installation, at 25% and 60% completion stages.

.4 Upon completion of installation.

.3 Submit manufacturer's reports to Consultant within 3 days of manufacturer representative's review.

.4 Make adjustments and corrections in accordance with written report.

.2 Inspection and Certification:

.1 Experienced and competent sound and vibration testing professional engineer to take vibration measurement for HVAC systems after start up and TAB of systems to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.2 Provide Consultant with notice 24 hours in advance of commencement of tests.

.3 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations (including sound curves).

.4 Submit complete report of test results including sound curves.

3.4 CLEANING

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

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

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.

.2 Sustainable requirements for construction and verification.

.2 Related Requirements

.1 Section 21 13 13

.2 Section 23 01 01

.3 Section 23 05 15.

1.2 REFERENCE STANDARDS

.1 Canadian Gas Association (CGA)

.1 CSA/CGA B149.1-05, Natural Gas and Propane Installation Code.

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.

.2 CAN/CGSB-24.3-92, Identification of Piping Systems.

.3 National Fire Protection Association (NFPA)

.1 NFPA 13-2002, Standard for the Installation of Sprinkler Systems.

.2 NFPA 14-2003, Standard for the Installation of Standpipe and Hose Systems.

1.3 SHOP DRAWING SUBMITTALS

.1 Product Data:

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

.3 Product data to include paint colour chips, other products specified in this section.

.4 Samples:

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

.2 Samples to include nameplates, labels, tags, lists of proposed legends.

1.4 QUALITY ASSURANCE

.1 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.2 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

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

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

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

.2 Dispose of unused paint and coating material at official hazardous material collections site approved by Consultant.

.3 Do not dispose of unused paint or coating material into sewer system, into streams, lakes, onto ground or in locations where it will pose health or environmental hazard.

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, capacity.

.2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 SYSTEM NAMEPLATES

.1 Colours:

.1 Hazardous: red letters, white background.

.2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).

.2 Construction:

.1 3 mm thick laminated plastic matte finish, with square corners, letters accurately aligned and machine engraved into core.

.3 Sizes:

.1 Conform to following table:

Size # mm	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 Fasten nameplates securely in conspicuous place. Where nameplates cannot be mounted on cool surface, provide standoffs.

.6 Identify equipment type and number and service of areas or zone of building served.

.7 For each item of equipment which may be started automatically or remotely, add a red lamacoid plate, 2-1/2" x 9" (65 x 230 mm), reading: "WARNING. THIS EQUIPMENT IS AUTOMATICALLY CONTROLLED AND MAY START AT ANY TIME."

2.3 EXISTING IDENTIFICATION SYSTEMS

.1 Apply existing identification system to new work.

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

.3 Before starting work, obtain written approval of identification system from Consultant.

2.4 PIPING SYSTEMS GOVERNED BY CODES

.1 Identification:

.1 Natural gas: to CSA/CGA B149.1 and authority having jurisdiction.

.2 Propane gas: to CSA/CGA B149.1 and authority having jurisdiction.

.3 Sprinklers: to NFPA 13.

.4 Standpipe and hose systems: to NFPA 14.

2.5 IDENTIFICATION OF PIPING SYSTEMS

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

.2 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, arrows:

.1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.

.2 Other pipes: pressure sensitive plastic-coated cloth or vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.

.7 Colours and Legends:

.1 Where not listed, obtain direction from Consultant.

.2 Colours for legends, arrows: to following table:

Background colour:	Legend, arrows:
Yellow	BLACK
Green	WHITE
Red	WHITE

.3 Background colour marking and legends for piping systems:

Contents	**Background colour marking**	**Legend**
City water	Green	CITY WATER
Glycol	Green	GLYCOL
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Storm water	Green	STORM
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID

Refrigeration hot gas	Yellow	REF. HOT GAS
Fire protection water	Red	FIRE PROT. WTR
Sprinklers	Red	SPRINKLERS

2.6 IDENTIFICATION DUCTWORK SYSTEMS

.1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.

.2 Colours: back, or co-ordinated with base colour to ensure strong contrast.

2.7 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, location of tagged item.

2.8 CONTROLS COMPONENTS IDENTIFICATION

.1 Identify systems, equipment, components, controls, sensors with system nameplates specified in this section.

.2 Inscriptions to include function and (where appropriate) fail-safe position.

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 specified Section 09 91 23 - Interior Painting has been completed.

3.3 INSTALLATION

.1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.

.2 Provide NRTL (UL, CSA, ETL) registration plates as required by respective agency.

3.4 NAMEPLATES

.1 Provide metal nameplates on each piece of equipment, mechanically fastened with raised or recessed letters.

.2 Include registration plates, Underwriters' Laboratories and CSA approval, as required by respective agency and as specified. Indicate size, equipment model, manufacturer's name, serial number, voltage, cycle, phase and power of motors, all factory supplied.

.3 Locate nameplates so that they are easily read from floor level.

.4 Provide standoffs for nameplates on hot and/or insulated surfaces.

.5 Do not paint, insulate or cover nameplates.

3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

.1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, 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 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Consultant. Provide one copy (reduced in size if required) in each operating and maintenance manual.

.3 Number valves in each system consecutively.

3.7 CLEANING

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

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

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 Consultant 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, MN-1-2002.

.2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-1998.

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-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 TABB), 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, 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, 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 and confirm in writing to Consultant adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.

.2 Review specified standards and report to Consultant 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 Consultant for verification of TAB reports.

1.9 START OF TAB

.1 Notify Consultant 7 days prior to start of TAB.

.2 Start TAB when building is essentially completed, including:

.3 Installation of ceilings, doors, windows, other construction affecting TAB.

.4 Application of weatherstripping, sealing, and caulking.

.5 Pressure, leakage, other tests specified elsewhere Division 23.

.6 Provisions for TAB installed and operational.

.7 Start-up, 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, clean.

.2 Duct systems clean.

.3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.

.4 Correct fan rotation.

.5 Fire, smoke, volume control dampers installed and open.

.6 Coil fins combed, clean.

.7 Access doors, installed, closed.

.8 Outlets installed, volume control dampers open.

.3 Liquid systems:

.1 Flushed, filled, vented.

.2 Correct pump rotation.

.3 Strainers in place, baskets clean.

.4 Isolating and balancing valves installed, open.

.5 Calibrated balancing valves installed, at factory settings.

.6 Chemical treatment systems complete, operational.

1.10 APPLICATION TOLERANCES

.1 Do TAB to following tolerances of design values:

.1 Laboratory HVAC systems: plus 10 %, minus 0 %.

.2 Other HVAC systems: plus 5 %, minus 5 %.

.3 Hydronic 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 Consultant 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 Consultant.

1.13 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit, prior to commencement of TAB:

.2 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.14 PRELIMINARY TAB REPORT

.1 Submit for checking and approval of Consultant, prior to submission of formal TAB report, sample of rough TAB sheets. Include:

.1 Details of instruments used.

.2 Details of TAB procedures employed.

.3 Calculations procedures.

.4 Summaries.

1.15 TAB REPORT

.1 Format in accordance with referenced standard.

.2 TAB report to show results in units matching drawings and to include:

.1 Project record drawings.

.2 System schematics.

.3 Submit 2 copies of TAB Report to Consultant for verification and approval, in in D-ring binders, complete with index tabs if hard copies are requested.

1.16 VERIFICATION

.1 Reported results subject to verification by Consultant.

.2 Provide personnel and instrumentation to verify up to 30 % of reported results.

.3 Number and location of verified results as directed by Consultant.

.4 Pay costs to repeat TAB as required to satisfaction of Consultant.

1.17 SETTINGS

.1 After TAB is completed to satisfaction Consultant, replace drive guards, close access doors, lock devices in set positions, 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.

1.18 COMPLETION OF TAB

.1 TAB considered complete when final TAB Report received and approved by Consultant.

1.19 AIR SYSTEMS

.1 Standard: TAB to most stringent of this section or TAB standards of AABC NEBB, SMACNA, or ASHRAE.

.2 Do TAB of systems, equipment, components, controls specified Division 23

.3 Qualifications: personnel performing TAB current member in good standing of AABC or NEBB.

.4 Quality assurance: perform TAB under direction of supervisor qualified by AABC or NEBB.

.5 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.

.6 Locations of equipment measurements: to include as appropriate:

.1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.

.2 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).

1.20 OTHER TAB REQUIREMENTS

.1 General requirements applicable to work specified this paragraph:

.1 Qualifications of TAB personnel: as for air systems specified this section.

.2 Quality assurance: as for air systems specified this section.

.2 Laboratory fume hoods:

.1 Standard: Treasury Board of Canada Handbook of Occupational Health and safety, 4th edition, Canada Labour Code state applicable Provincial or other standard.

.2 TAB procedures: as described in standard.

2. PRODUCTS

2.1 NOT USED

.1 Not used.

3. EXECUTION

3.1 NOT USED

.1 Not used.

END OF SECTION

1. GENERAL

1.1 SUMMARY

.1 Section Includes:

.1 Materials and methods for pressure testing ducts over 5 m in length, forming part of a supply, return or exhaust ductwork system directly or indirectly connected to air handling equipment.

.2 Related Requirements

.1 Section 23 01 01.

.2 Section 23 31 00.

.3 Section 23 33 00.

1.2 REFERENCE STANDARDS

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

.1 Safety Data Sheets (SDS).

.2 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)

.1 SMACNA HVAC Air Duct Leakage Test Manual, 1985.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties. Include pressure test information and results as follows:

.1 Submit proposed report form and test report format to Consultant for approval at least three months before proposed date of first series of tests. Do not start tests until approval received in writing from Consultant.

.2 Prepare report of results and submit to Consultant within 24 hours of completion of tests. Include:

.1 Schematic of entire system.

.2 Schematic of section under test showing test site.

.3 Required and achieved static pressures.

.4 Orifice differential pressure at test sites.

.5 Permissible and actual leakage flow rate for test sites.

.6 Witnessed certification of results.

.3 Include test reports in final TAB report.

.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Instructions: submit manufacturer's installation instructions.

1.4 QUALITY ASSURANCE

.1 Pre-Installation Meetings:

.1 Convene pre-installation meeting one week prior to beginning work of this Section and on-site installations in accordance with [Section 01 32 16.16 - Construction Progress Schedule - Critical Path Method (CPM).

.1 Verify project requirements.

.2 Review installation and substrate conditions.

.3 Co-ordination with other building subtrades.

.4 Review manufacturer's installation instructions and warranty requirements.

.2 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

2. PRODUCTS

2.1 TEST INSTRUMENTS

.1 Test apparatus to include:

.1 Fan capable of producing required static pressure.

.2 Duct section with calibrated orifice plate mounted and accurately located pressure taps.

.3 Flow measuring instrument compatible with the orifice plate.

.4 Calibration curves for orifice plates used.

.5 Flexible duct for connecting to ductwork under test.

.6 Smoke bombs for visual inspections.

.2 Test apparatus: accurate to within +/- 3 % of flow rate and pressure.

.3 Submit details of test instruments to be used to Consultant at least three months before anticipated start date.

.4 Test instruments: calibrated and certificate of calibration deposited with Consultant no more than 28 days before start of tests.

.5 Re-calibrated every six months thereafter.

2.2 EQUIPMENT LEAKAGE TOLERANCES

.1 Equipment and system components such as VAV boxes, duct heating leakage: 2 %.

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 TEST PROCEDURES

.1 Maximum lengths of ducts to be tested consistent with capacity of test equipment.

.2 Section of duct to be tested to include:

.1 Fittings, branch ducts, tap-ins.

.3 Repeat tests until specified pressures are attained. Bear costs for repairs and repetition to tests.

.4 Base partial system leakage calculations on SMACNA HVAC Air Duct Leakage Test Manual.

.5 Seal leaks that can be heard or felt, regardless of their contribution to total leakage.

3.3 SITE TOLERANCES

.1 System leakage tolerances specified are stated as percentage of total flow rate handled by system. Pro-rate specified system leakage tolerances. Leakage for sections of duct systems: not to exceed total allowable leakage.

.2 Leakage tests on following systems not to exceed specified leakage rates.

.1 Small duct systems up to 250 Pa: leakage 2%.

.2 VAV box and duct on downstream side of VAV box: leakage 2%.

.3 Large low pressure duct systems up to 500 Pa: leakage 2%.

.4 HP duct systems up to 1000 Pa pressure classification, including upstream side of VAV boxes: leakage 1%.

.3 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

3.4 TESTING

.1 Test ducts before installation of insulation or other forms of concealment.

.2 Test after seals have cured.

.3 Test when ambient temperature will not affect effectiveness of seals, and gaskets.

.4 Flexible connections to VAV boxes.

3.5 FIELD QUALITY CONTROL

.1 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 Manufacturer's Field Services: 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 Consultant.

.2 Performance Verification:

.1 Consultant to witness tests and to verify reported results.

.2 To be certified by same TAB agency approved by Consultant to undertake TAB on this project.

3.6 CLEANING

.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1. GENERAL

1.1 GENERAL REQUIREMENTS

.1 Refer to Section 23 01 01.

.2 Refer to Section 23 31 00.

.3 Refer to Section 23 32 48.

.4 Refer to Section 23 33 53.

1.1 REFERENCE STANDARDS

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

.1 ANSI/ASHRAE/IESNA 90.1-2013, Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 ASTM International (ASTM)

.1 ASTM B209M-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

.2 ASTM C335-05ae1, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.

.3 ASTM C411-05, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.

.4 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.5 ASTM C547-07e1, Standard Specification for Mineral Fiber Pipe Insulation.

.6 ASTM C553-02e1, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

.7 ASTM C612-04e1, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

.8 ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.9 ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB)

.1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.4 Canada Green Building Council (CaGBC)

.1 LEED Canada-NC Version 1.0-2004, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package For New Construction and Major Renovations.

.2 Rating System Addenda for New Construction and Major Renovations LEED Canada-NC Version 1.0-Addendum 2007.

.3 LEED Canada-CI Version 1.0-2007, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Guide For Commercial Interiors.

.5 Green Seal Environmental Standards (GSES)

.1 Standard GS-36-00, Commercial Adhesives.

.6 South Coast Air Quality Management District (SCAQMD), California State

.1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

.7 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).

.8 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S102-03, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC-S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.2 DEFINITIONS

.1 For purposes of this section:

.1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.

.2 "EXPOSED" - means "not concealed" as previously defined.

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

.2 TIAC Codes:

.1 CRD: Code Round Ductwork,

.2 CRF: Code Rectangular Finish.

1.3 SHOP DRAWING 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 duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.

.1 Description of equipment giving manufacturer's name, type, model, year and capacity.

.2 Details of operation, servicing and maintenance.

.3 Recommended spare parts list.

.3 Samples:

.1 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed.

.2 Mount sample on 12 mm plywood board.

.3 Affix typewritten label beneath sample indicating service.

.4 Manufacturers' Instructions:

.1 Provide manufacture's written duct insulation jointing recommendations. and special handling criteria, installation sequence, cleaning procedures.

1.4 QUALITY ASSURANCE

.1 Qualifications:

.1 Installer: specialist in performing work of this section and have at least 3 years successful experience in this size and type of project, member of TIAC.

1.5 DELIVERY, STORAGE AND HANDLING

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

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address and ULC markings.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

2. PRODUCTS

2.1 FIRE AND SMOKE RATING

.1 To CAN/ULC-S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

.1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.

.3 TIAC Code C-1: Rigid mineral fibre board to ASTM C612, with or without factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).

.4 TIAC Code C-2: Mineral fibre blanket to ASTM C553 faced with or without factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).

.1 Mineral fibre: to ASTM C553.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: to ASTM C553.

2.3 JACKETS

.1 Canvas:

.1 220 gm/m^2 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.

.2 Lagging adhesive: compatible with insulation.

.1 Maximum VOC limit 250 g/L to GSES GS-36.

.3 Aluminum:

.1 To ASTM B209 with and without moisture barrier as scheduled in PART 3 of this section.

.2 Thickness: 0.50 mm sheet.

.3 Finish: Smooth, Stucco embossed or Corrugated.

.4 Jacket banding and mechanical seals: 19 mm wide, 0.5 mm thick stainless steel.

.4 Stainless steel:

.1 Type: 316

.2 Thickness: 0.50 mm sheet.

.3 Finish: Smooth, Stucco embossed or Corrugated.

.4 Jacket banding and mechanical seals: 19 mm wide, 0.5 mm thick stainless steel.

2.4 ACCESSORIES

.1 Vapour retarder lap adhesive:

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

.2 Indoor Vapour Retarder Finish:

.1 Vinyl emulsion type acrylic, compatible with insulation.

.3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.

.4 ULC Listed Canvas Jacket:

.1 220 gm/m^2 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.

.5 Outdoor Vapour Retarder Mastic:

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: Fibrous glass, untreated 305 g/m^2.

.6 Tape: self-adhesive, aluminum, reinforced, 75 mm wide minimum.

.7 Contact adhesive: quick setting

.8 Canvas adhesive: washable.

.9 Tie wire: 1.5mm stainless steel.

.10 Banding: 19 mm wide, 0.5 mm thick stainless steel.

.11 Facing: 25 mm stainless steel hexagonal wire mesh stitched on both faces of insulation.

.12 Fasteners: 4 mm diameter pins with 35 mm diameter round or square clips, length to suit thickness of insulation.

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 PRE-INSTALLATION REQUIREMENTS

.1 Pressure test ductwork systems complete, witness and certify.

.2 Ensure surfaces are clean, dry, free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards.

.2 Apply materials in accordance with manufacturers instructions and as indicated.

.3 Use 2 layers with staggered joints when required nominal thickness exceeds 75 mm.

.4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Ensure hangers and supports are outside vapour retarder jacket.

.5 Hangers and supports in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

.1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.

.6 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum 2 rows each side.

3.4 DUCTWORK INSULATION SCHEDULE

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

Service	Insulation Type	Thickness
Air Supply – Rectangular	Rigid	See below
Air Supply – Round	Flexible	See below
Exhaust Within 6’ (1.5m) of Exterior – Rectangular	Rigid	See below (Exterior)
Exhaust Within 6’ (1.5m) of Exterior – Round	Flexible	See below (Exterior)
Fresh Air Intake – Rectangular	Rigid	See below (Exterior)
Fresh Air Intake – Round	Flexible	See Below (Exterior)
Exhaust Air Plenums	Rigid	See below (Exterior)
Supply Runouts to Terminal Units – Rectangular	Rigid	See below
Supply Runouts to Terminal Units – Round	Flexible	See below
Duct Mounted Coils	Rigid	See below (unconditioned space)

Duct Location	Heating Only Ducts	Cooling Only Ducts	Return Ducts	Combined Heating & Cooling Ducts
Exterior	R-12	R-12	R-12	R-12
Ventilated Attic	R-6	R-1.9	R-3.5	R-6
Unventilated Attic Above Insulated Ceiling	R-12	R-12	R-12	R-12
Unventilated Attic with Roof Insulation	None	R-1.9	None	R-1.9
Unconditioned Space	R-12	R-12	R-12	R-12
Indirectly Conditioned Space	None	None	None	None
Buried	R-6	None	None	R-3.5

.2 Exposed round ducts 600 mm and larger, smaller sizes where subject to abuse:

.1 Use TIAC code C-1 insulation, scored to suit diameter of duct.

.1 Finishes: conform to following table:

	TIAC Code	
	Rectangular	**Round**
Indoor, concealed	none	none
Indoor, exposed within mechanical room	CRF/1	CRD/2
Indoor, exposed elsewhere	CRF/2	CRD/3
Outdoor, exposed to precipitation	CRF/3	CRD/4
Outdoor, elsewhere	CRF/4	CRD/5

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

1. GENERAL

1.1 GENERAL REQUIREMENTS

.1 Refer to Section 23 01 01.

1.1 REFERENCE STANDARDS

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

.1 ANSI/ASHRAE 90.1-2013, Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 ASTM International (ASTM)

.1 ASTM C335-05ae1, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.

.2 ASTM C449/C449M-07, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.3 ASTM C533-07, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.

.4 ASTM C547-07, Standard Specification for Mineral Fiber Pipe Insulation.

.5 ASTM C553-02, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

.6 ASTM C612-04e1, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

.7 ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.8 ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB)

.1 CGSB 51-GP-52MA-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.2 CAN/CGSB 51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts.

.4 Canada Green Building Council (CaGBC)

.1 LEED Canada-NC Version 1.0-2004, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package For New Construction and Major Renovations (including Addendum 2007).

.2 LEED Canada-CI Version 1.0-2007, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Guide For Commercial Interiors.

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

.1 Safety Data Sheets (SDS).

.6 South Coast Air Quality Management District (SCAQMD), California State

.1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

.7 Thermal Insulation Association of Canada (TIAC)

.1 National Insulation Standards 2005.

.8 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S102-07, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.2 SHOP DRAWING 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 insulation and adhesives, include product characteristics, performance criteria, physical size, finish and limitations.

.2 Provide two copies WHMIS SDS - Safety Data Sheets in accordance with Section 01 35 29.06 - Health and Safety Requirements.

.3 Samples:

.1 Provide for review: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed.

.1 Mount sample on 12 mm plywood board.

.2 Affix typewritten label beneath sample indicating service.

.4 Manufacturer's Instructions:

.1 Include procedures to be used and installation standards to be achieved.

.5 Qualifications:

.1 Installer to be specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, member of TIAC.

1.3 DELIVERY, STORAGE AND HANDLING

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

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Store at temperatures and conditions recommended by manufacturer.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

2. PRODUCTS

2.1 FIRE AND SMOKE RATING

.1 Fire and smoke ratings to CAN/ULC-S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

.1 Mineral fibre: includes glass fibre, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.

.3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.

.1 Mineral fibre: ASTM C547.

.2 Maximum "k" factor: ASTM C547.

.4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.

.1 Mineral fibre: ASTM C547.

.2 Jacket: to CGSB 51-GP-52MA.

.3 Maximum "k" factor: ASTM C547.

.5 TIAC Code C-1: rigid mineral fibre board, unfaced.

.1 Mineral fibre: ASTM C612.

.2 Maximum "k" factor: ASTM C612.

.6 TIAC Code C-4: rigid mineral fibre board faced with factory applied vapour retarder jacket.

.1 Mineral fibre: ASTM C612.

.2 Jacket: to CGSB 51-GP-52MA.

.3 Maximum "k" factor: ASTM C612.

.7 TIAC Code C-2: mineral fibre blanket unfaced or faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).

.1 Mineral fibre: ASTM C553.

.2 Jacket: to CGSB 51-GP-52MA.

.3 Maximum "k" factor: ASTM C553.

.8 TIAC Code A.6: flexible unicellular tubular elastomer.

.1 Insulation: with vapour retarder jacket.

.2 Jacket: to CGSB 51-GP-52MA.

.3 Maximum "k" factor.

.4 Certified by manufacturer free of potential stress corrosion cracking corrodents.

.9 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.

.1 Insulation: ASTM C533.

.2 Maximum "k" factor: ASTM C533.

.3 Design to permit periodic removal and re-installation.

2.3 CEMENT

.1 Thermal insulating and finish

.1 To: ASTM C449/C449M.

.2 Hydraulic setting or air drying on mineral wool, to ASTM C449.

2.4 JACKETS

.1 Polyvinyl Chloride (PVC):

.1 One-piece moulded type and sheet to CAN/CGSB 51.53 with pre-formed shapes as required.

.2 Colours: to match adjacent finish paint for existing construction or selected by Consultant for new construction.

.3 Minimum service temperatures: -20 degrees C.

.4 Maximum service temperature: 65 degrees C.

.5 Moisture vapour transmission: 0.02 perm.

.6 Thickness: 0.5 mm.

.7 Fastenings:

.1 Use solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Tacks.

.3 Pressure sensitive vinyl tape of matching colour.

.8 Special requirements:

.1 Outdoor: UV rated material at least 0.5 mm thick.

.9 Covering adhesive: compatible with insulation.

.2 ABS Plastic:

.1 One-piece moulded type and sheet with pre-formed shapes as required.

.2 Colours: to match adjacent finish paint for existing construction or selected by Consultant for new construction.

.3 Minimum service temperatures: -40 degrees C.

.4 Maximum service temperature: 82 degrees C.

.5 Moisture vapour transmission: 0.012 perm.

.6 Thickness: 0.75 mm.

.7 Fastenings:

.1 Solvent weld adhesive compatible with insulation to seal laps and joints

.2 Tacks.

.3 Pressure sensitive vinyl tape of matching colour.

.8 Locations:

.1 For outdoor use ONLY.

.3 Canvas:

.1 220 gm/m^2 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.

.2 Lagging adhesive: compatible with insulation.

.4 Aluminum:

.1 To ASTM B209.

.2 Thickness: 0.5 mm sheet.

.3 Finish: smooth, stucco embossed or corrugated (match existing where applicable).

.4 Joining: longitudinal and circumferential slip joints with 50 mm laps.

.5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

.5 Stainless steel:

.1 Type: 316.

.2 Thickness: 0.25 mm.

.3 Finish: smooth, stucco embossed or corrugated (match existing where applicable).

.4 Joining: longitudinal and circumferential slip joints with 50 mm laps.

.5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

2.5 INSULATION SECUREMENTS

.1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.

.2 Contact adhesive: quick setting.

.3 Canvas adhesive: washable.

.4 Tie wire: 1.5 mm diameter stainless steel.

.5 Bands: Stainless steel, 19 mm wide, 0.5 mm thick.

.6 Facing: 25 mm galvanized steel hexagonal wire mesh on both faces of insulation. Fasteners: 4mm diameter pins with 35 mm diameter round or square clips. Length of pin to suit thickness of insulation.

2.6 VAPOUR RETARDER LAP ADHESIVE

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

2.7 INDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

2.8 OUTDOOR VAPOUR RETARDER MASTIC

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: Fibrous glass, untreated 305 g/m^2.

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 PRE- INSTALLATION REQUIREMENTS

.1 Pressure testing of equipment and adjacent piping systems complete, witnessed and certified.

.2 Surfaces clean, dry, free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards

.1 Hot equipment: To TIAC code 1503-H.

.2 Cold equipment: to TIAC code 1503-C.

.2 Elastomeric Insulation: to remain dry. Overlaps to manufacturer's instructions. Joints tight and sealed properly.

.3 Provide vapour retarder as recommended by manufacturer.

.4 Apply materials in accordance with insulation and equipment manufacturer's instructions and this specification.

.5 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.

.6 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Hangers, supports outside vapour retarder jacket.

.7 Supports, Hangers:

.1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

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

.2 Installation to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.

3.5 FIRE SUPPRESSION EQUIPMENT INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.

.2 Hot Equipment:

.1 TIAC code A-1 or C-1 with mechanical fastenings or wire or bands and 13 mm cement reinforced with one layer of reinforcing mesh.

.2 TIAC code C-2 unfaced with wire or bands and 13 mm cement precede by one layer of reinforcing mesh.

.3 Thicknesses:

	Unfired Domestic hot water storage tanks: R12.5 equivalent thickness.

.3 Breechings, engine exhausts and mufflers:

.1 TIAC code A-2 with 25 mm air gap, mechanical fastenings or wire or bands and 13 mm cement reinforced with one layer of reinforcing mesh.

.4 Cold equipment:

.1 TIAC A-3 or C-4 with mechanical fastenings or wire or bands and 13 mm cement reinforced with one layer of reinforcing mesh.

.2 TIAC C-2 faced with vapour retardant jacket and with wire or bands and 13 mm cement preceded by one layer of reinforcing mesh.

.3 TIAC A-6 or C-4 with mechanical fastenings or wire or bands.

.4 Thicknesses:

.1 Chillers (except factory insulated) - 50 mm.

.2 ERV’s – 50 mm.

.5 Finishes:

.1 Engine exhaust piping and muffler: To TIAC code CRF-4.

.2 Equipment in mechanical rooms: TIAC code CEF/1 with PVC jacket.

.3 Equipment elsewhere: TIAC code CEF/2 with 13 mm cement jacket.

3.6 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

1. GENERAL

1.1 SUMMARY

.1 Section Includes:

.1 Thermal insulation for piping and piping accessories in commercial type applications.

.2 Related Requirements

.1 Section 23 01 01.

1.2 REFERENCE STANDARDS

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

.1 ASHRAE Standard 90.1-2013, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).

.2 ASTM International (ASTM)

.1 ASTM B209M-04, Standard Specification for Aluminum and Aluminum Alloy Sheet.

.2 ASTM C335-04, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.

.3 ASTM C411-04, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.

.4 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.5 ASTM C533-2004, Calcium Silicate Block and Pipe Thermal Insulation.

.6 ASTM C547-2003, Mineral Fiber Pipe Insulation.

.7 ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.8 ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB)

.1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.2 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts

.4 Department of Justice Canada (Jus)

.1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.

.2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.

.3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

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

.1 Safety Data Sheets (SDS).

.6 Manufacturer's Trade Associations

.1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).

.7 Underwriters' Laboratories of Canada (ULC)

.1 CAN/ULC-S102-03, Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC-S701-01, Thermal Insulation, Polystyrene, Boards and Pipe Covering.

.3 CAN/ULC-S702-1997, Thermal Insulation, Mineral Fibre, for Buildings

.4 CAN/ULC-S702.2-03, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.3 DEFINITIONS

.1 For purposes of this section:

.1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.

.2 "EXPOSED" - will mean "not concealed" as specified.

.2 TIAC ss:

.1 CRF: Code Rectangular Finish.

.2 CPF: Code Piping Finish.

1.4 SHOP DRAWING SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Safety Data Sheets (SDS) in accordance with Section 01 33 00 - Submittal Procedures.

.3 Shop Drawings:

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

.4 Samples:

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

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

.5 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Instructions: submit manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

.1 Qualifications:

.2 Installer: specialist in performing work of this Section and have at least 3 years successful experience in this size and type of project, member of TIAC.

.3 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.3 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.2 Storage and Protection:

.1 Protect from weather, construction traffic.

.2 Protect against damage.

.3 Store at temperatures and conditions required by manufacturer.

.3 Waste Management and Disposal:

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

.2 Place excess or unused insulation and insulation accessory materials in designated containers.

.3 Divert unused metal materials from landfill to metal recycling facility approved by Consultant.

.4 Dispose of unused adhesive material at official hazardous material collections site approved by Consultant.

2. PRODUCTS

2.1 FIRE AND SMOKE RATING

.1 In accordance with CAN/ULC-S102.

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

.1 Mineral fibre specified includes glass fibre, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.

.3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/ULC-S702 and ASTM C547.

.2 Maximum "k" factor: to CAN/ULC-S702.

.4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/ULC-S702 and ASTM C547.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: to CAN/ULC-S702 and ASTM C547.

.5 TIAC Code C-2: mineral fibre blanket faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).

.1 Mineral fibre: to CAN/ULC-S702 and ASTM C547.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: to CAN/ULC-S702 and ASTM C547.

.6 TIAC Code A-6: flexible unicellular tubular elastomer.

.1 Insulation: with vapour retarder jacket.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Certified by manufacturer: free of chemicals with potential to cause stress corrosion cracking in steel and stainless steel.

.7 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.

.1 Insulation: to ASTM C533.

.2 Design to permit periodic removal and re-installation.

2.3 INSULATION SECUREMENT

.1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.

.2 Contact adhesive: quick setting.

.3 Canvas adhesive: washable.

.4 Tie wire: 1.5 mm diameter stainless steel.

.5 Bands: stainless steel, 19 mm wide, 0.5 mm thick.

2.4 CEMENT

.1 Thermal insulating and finishing cement:

.1 Hydraulic setting or air drying] on mineral wool, to ASTM C449/C449M.

2.5 VAPOUR RETARDER LAP ADHESIVE

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

2.6 INDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

2.7 OUTDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: fibrous glass, untreated 305 g/m^2.

2.8 JACKETS

.1 Polyvinyl Chloride (PVC):

.1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.

.2 Colours: to match adjacent finish paint for existing construction and by consultant for new construction.

.3 Minimum service temperatures: -20 degrees C.

.4 Maximum service temperature: 65 degrees C.

.5 Moisture vapour transmission: 0.02 perm.

.6 Thickness: 0.5 mm.

.7 Fastenings:

.1 Use solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Tacks.

.3 Pressure sensitive vinyl tape of matching colour.

.8 Special requirements:

.1 Outdoor: UV rated material at least 0.5 mm thick.

.2 ABS Plastic:

.1 One-piece moulded type and sheet with pre-formed shapes as required.

.2 Colours: to match adjacent finish paint for existing construction and by consultant for new construction.

.3

.4 Minimum service temperatures: -40 degrees C.

.5 Maximum service temperature: 82 degrees C.

.6 Moisture vapour transmission: 0.012 perm.

.7 Thickness: 0.75 mm.

.8 Fastenings:

.1 Solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Tacks.

.3 Pressure sensitive vinyl tape of matching colour.

.9 Locations:

.1 For outdoor use ONLY.

.3 Canvas:

.1 220 gm/m^2 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.

.2 Lagging adhesive: compatible with insulation.

.4 Aluminum:

.1 To ASTM B209.

.2 Thickness: 0.5 mm sheet.

.3 Finish: smooth, stucco embossed or corrugated to match existing where applicable.

.4 Joining: longitudinal and circumferential slip joints with 50 mm laps.

.5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

.5 Stainless steel:

.1 Type: 316.

.2 Thickness: 0.25 mm.

.3 Finish: smooth, stucco embossed or corrugated to match existing where applicable.

.4 Joining: longitudinal and circumferential slip joints with 50 mm laps.

.5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

2.9 WEATHERPROOF CAULKING FOR JACKETS INSTALLED OUTDOORS

.1 Caulking to: Section 07 92 00 - Joint Sealants.

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 PRE-INSTALLATION REQUIREMENT

.1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.

.2 Surfaces clean, dry, free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards.

.2 Apply materials in accordance with manufacturers instructions and this specification.

.3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.

.4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Install hangers, supports outside vapour retarder jacket.

.5 Supports, Hangers:

.1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PREFABRICATED, INSULATION AND ENCLOSURES

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

.2 Design: to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.

.3 Insulation:

.1 Insulation, fastenings and finishes: same as system.

.2 Jacket: Aluminum.

3.5 INSTALLATION OF ELASTOMERIC INSULATION

.1 Insulation to remain dry. Overlaps to manufacturers instructions. Ensure tight joints.

.2 Provide vapour retarder as recommended by manufacturer.

3.6 PIPING INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.

.2 TIAC Code: A-1.

- .1 Securements: tape at 300 mm on centre.
- .2 Seals: lap seal adhesive, lagging adhesive.
- .3 Installation: TIAC Code 1501-H.

.3 TIAC Code: A-3.

- .1 Securements: Tape at 300 mm on centre.
- .2 Seals: VR lap seal adhesive, VR lagging adhesive.
- .3 Installation: TIAC Code: 1501-C.

.4 TIAC Code: A-6.

- .1 Insulation securements: Tape at 300 mm on centre.
- .2 Seals: lap seal adhesive, lagging adhesive.
- .3 Installation: TIAC Code: 1601-C.

.5 TIAC Code: C-2 with vapour retarder jacket.

- .1 Insulation securements: Tape at 300 mm on centre.
- .2 Seals: lap seal adhesive, lagging adhesive.
- .3 Installation: TIAC Code: 1501-C.

.6 TIAC Code: A-2.

- .1 Insulation securements: SS bands at 300mm on centre.
- .2 Seals: lap seal adhesive, lagging adhesive.
- .3 Installation: TIAC Code: 1501-H.

.7 Thickness of insulation as listed in following table.

- .1 Run outs to individual units and equipment not exceeding 4000 mm long.
- .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Media	Temp °C	TIAC Code	Pipe Size NPS				
			<1	1 to <1.5	1.5 to 4	4 to <8	8+
Glycol Heating	60 - 93	A-1	38	38	50	50	50
Glycol Heating	up to 59	A-1	25	25	38	38	38
Domestic HWS	60 - 93	A-1	38	38	50	50	50
Chilled Water or Glycol	below 4	A-3	13	25	25	25	38
Chilled Water Pump Casing		A-3	25	25	25	25	25
Domestic CWS		A-3	25	25	25	25	25
Domestic CWS with vapour retarder		C-2	25	25	25	25	25
Refrigerant	4 - 13	A-6	25	25	25	25	25
Refrigerant	below 4	A-6	25	25	38	38	38
RWL and RWP		C-2	25	25	25	25	25
Cooling Coil cond. drain		C-2	25	25	25	25	25

.8 Finishes:

.1 Exposed indoors: PVC jacket.

.2 Exposed in mechanical rooms: canvas or PVC jacket.

.3 Concealed, indoors: canvas on valves, fittings. No further finish.

.4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.

.5 Outdoors: water-proof aluminum or SS jacket.

.6 Finish attachments: SS bands, at 150 mm on centre. Seals: closed.

.7 Installation: to appropriate TIAC code CRF/1 through CPF/5.

3.7 FIELD QUALITY CONTROL

.1 Verification requirements in accordance with Section 01 33 29 - Sustainable Design Reporting, include:

.1 Materials and resources.

.2 Storage and collection of recyclables.

.3 Construction waste management.

.4 Resource reuse.

.5 Recycled content.

.6 Local/regional materials.

.7 Certified wood.

.8 Low-emitting materials.

3.8 CLEANING

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

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 01 01.

1.2 COMMISSIONING AGENT

.1 The commissioning agent (CA) has been contracted directly by the Owner for this project. The CA has overall responsibility for planning and coordinating the commissioning process. Commissioning involves all parties to the design and construction process, including the Contractor and his sub-contractors and suppliers.

1.3 DESCRIPTION OF WORK

.1 The purpose of the commissioning process is to provide the owner/operator of the facility with assurance that the plumbing systems have been installed according to the contract documents and operate within the performance guidelines set out in the design intent documents and these specifications. The CA will provide the Owner with an unbiased, objective view of the system's installation, operation, and performance. The commissioning process does not take away or reduce the responsibility of the installing contractors to provide a finished product, installed and fully functional in accordance with the contract documents.

.2 Commissioning is intended to enhance the quality of system start up and aid in the orderly completion and transfer of systems for beneficial use of owner. The CA will be the leader of the commissioning team, planning and coordinating all commissioning activities in conjunction with the design professionals, construction manager, subcontractors, manufacturers, and equipment suppliers.

.3 The General Contractor and Division 21, 22, 23, 25, 26, 27 and 28 sub-contractors are responsible for cooperating, and coordinating their work, with the CA. They shall also be responsible for carrying out all the physical activities required for installation of components and systems and operating them during the commissioning process as required in this Section.

1.4 RELATED DOCUMENTS

.1 Drawings and General Requirements of the contract, including General and Supplementary General Conditions, General Requirements, and applicable Sections of Divisions 21, 22, 23, 25, 26, 27 and 28 apply to work of this Section.

.2 Refer to specification section Appendix C.

1.5 REFERENCES

.1 Ontario Building Code (OBC).

.2 Ontario Fire Code (OFC).

.3 ASHRAE Guideline 0 The Commissioning Process,

1.6 SYSTEMS TO BE COMMISSIONED

.1 HVAC

.2 Plumbing

.3 Building Automation System

.4 Lighting

.5 Power

2 PRODUCTS

2.1 COMMISSIONING AUTHORITY

.1 The commissioning authority shall consist of representatives of the following:

.1 Owner and the Owner's Operating and Maintenance Staff

.2 Architect

.3 Mechanical Design Engineer

.4 Electrical Design Engineer

.5 Commissioning Consultant (CC)

.6 General Contractor

.7 Fire Protection Subcontractor

.8 Mechanical Subcontractor

.9 Controls Subcontractor

.10 Electrical Subcontractor

.11 Testing, Adjusting and Balancing Agency

.12 Related Subcontractors and Suppliers.

2.2 SYSTEMS START-UP/VERIFICATION CHECKLISTS

.1 HVAC

.2 Plumbing

.3 Building Automation

.4 Lighting

.5 Power

2.3 FUNCTIONAL PERFORMANCE TEST CHECKLISTS

.1 HVAC

.2 Plumbing

.3 Building Automation

.4 Lighting

.5 Power

3 EXECUTION

3.1 COMMISSIONING CONSULTANT'S RESPONSIBILITIES

.1 The Commissioning Consultant shall:

.1 plan, organize and implement the commissioning process as specified herein.

.2 prepare the commissioning plan, ensure its distribution for review and comment.

.3 revise the commissioning plan as required during construction.

.4 chair commissioning meetings and prepare and distribute minutes to all commissioning team members, whether or not they attended the meeting.

.5 in conjunction with the General Contractor, coordinate commissioning activities among all contractors, sub-trades and suppliers.

.6 monitor system verification checks, and ensure the results are documented as the checks are done.

.7 monitor controls point-to-point checks done by the controls contractor, and ensure the results documented as the checks are done.

.8 observe all start-ups and initial system operations tests and checks.

.9 direct the contractors to operate equipment and systems as required to ensure that all required functional performance tests are carried out for verification purposes.

.10 witness all functional performance tests and document the results.

.11 prepare and submit a commissioning report which documents all checks and tests done throughout the commissioning process, and the results obtained from each; and

.12 ensure all required O&M manuals, instructions and demonstrations are provided to the owner's designated operating staff.

3.2 MECHANICAL ENGINEER'S RESPONSIBILITIES

.1 The Mechanical Engineer will review the commissioning plan, and will participate, as appropriate, in on-site commissioning meetings.

.2 During the acceptance phase of the commissioning process, the Mechanical Engineer may be on site to review commissioning documentation, to witness functional performance tests, and to analyze the installation and its performance.

3.3 OWNER'S RESPONSIBILITIES

.1 The Owner will ensure the availability of operating staff for all scheduled

instructions and demonstration sessions. This staff will possess sufficient skills and knowledge to operate and maintain the installation following attendance at these sessions. The owner will also ensure the appropriate involvement of the Electrical Engineer, Architect, and any other consultants as required, in the commissioning process.

3.4 GENERAL CONTRACTOR'S RESPONSIBILITIES

.1 The General Contractor has responsibility to ensure the overall completion of the work and shall.

.1 participate as required in the HVAC Systems Commissioning process,

.2 ensure the HVAC contractor performs all assigned commissioning responsibilities as specified in 3.5,

.3 ensure the testing, adjusting and balancing agency performs all assigned commissioning responsibilities as specified in 3.6,

.4 ensure the Division 25 sub-contractor performs all assigned commissioning responsibilities as specified in 3.7,

.5 ensure the Division 26 sub-contractor performs all assigned commissioning responsibilities as specified in 3.8,

.6 ensure the cooperation and participation in the commissioning process of all other sub-contractors as applicable.

.2 The General Contractor shall assign a representative to the commissioning team, and submit the person's name to the commissioning agency, within one (1) month of the award of the contract. The representative shall have the authority to make decision on behalf of the general contractor as they relate to the organization and scheduling of HVAC commissioning. The representative shall facilitate communications among all contractors and suppliers and other commissioning team members and shall foster the necessary cooperative action. One specific responsibility shall be to attend commissioning meetings and ensure action items arising from them are attended to as required to allow the commissioning process to proceed on schedule.

.3 In the event that any scheduled equipment or system start-ups or functional performance tests are terminated because the CC or the mechanical engineer discover deficient or incomplete work, or due to the non-attendance of required contractor or supplier personnel, the contractor or sub-contractor responsible for the termination shall also be responsible for paying reasonable costs of time and travel expenses of any or all of the following representatives who were physically present for the purpose of witnessing the start-up or the FPT: the CC, the mechanical engineer, the electrical engineer, and the owner. The owner may provide a statement to the General Contractor identifying the specific activity that was terminated, the scheduled date, and a list of those in attendance, along with their reasonable time and travel expenses.

3.5 HVAC SUBCONTRACTOR'S RESPONSIBILITIES

.1 The HVAC sub-contractor, and all the sub-contractors and suppliers within

Division 23, shall cooperate with the commissioning consultant (CA), and other commissioning team members, to facilitate the successful completion of the commissioning process.

.2 The contractor shall assign a representative to the commissioning team, and submit the person's name to the commissioning agency, within one (1) month of the award of the contract. The representative shall have the authority to make decisions on behalf of the mechanical contractor as they relate to the organization and scheduling of HVAC commissioning. The representative shall ensure communications between Division 23 contractors and supplies and all other commissioning team members and shall foster the necessary cooperative action. One specific responsibility shall be to attend commissioning meetings and ensure action items arising from them are attended to as required to allow the commissioning process to proceed on schedule.

.3 The HVAC sub-contractor, and all mechanical sub-contractors and suppliers, shall cooperate with the Commissioning Agency in carrying out the HVAC commissioning process. In this context, the HVAC sub-contractor shall:

.1 include in their quotes the cost of participating in the commissioning process as specified herein.

.2 Ensure the Division 25 sub-contractor performs HVAC commissioning responsibilities as listed in 3.7.

.3 Provide instruction and demonstrations for the Owner's designated operating staff, in conjunction with the commissioning agency and mechanical engineer, and with the participation of qualified technicians from major equipment suppliers and the controls contractor.

.4 Include requirements for submittal data. O&M data, and training information in each purchase order or sub-contract written.

.5 Ensure cooperation and participation of specialty sub-contractors such as sheet metal, piping, refrigeration, and water treatment as applicable.

.6 Ensure participation of major equipment manufacturing in appropriate start-up, testing and training activities.

.7 Attend commissioning meetings scheduled by the CA.

.8 Notify the CA a minimum of two weeks in advance of scheduled equipment and system start-ups, so that the CA may witness system verifications, and equipment and system start-ups.

.9 Provide sufficient personnel to assist the CA as required during system verification and functional performance testing.

.10 Prior to set-up, inspect, check and confirm the correct and complete installation of all equipment and systems for which system verification checklists are included in the commissioning plan. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and re-check until the results are satisfactory, and the system is ready for safe start-up.

.11 Notify the CA a minimum of two weeks in advance of the time for start of the TAB work. Attend the initial TAB meeting for review of the TAB procedures.

.12 Provide equipment and systems start-up resources as specified and required. If during an attempted equipment or system start-up, deficient or incomplete work is discovered that would preclude safe operation, the start-up shall be aborted until corrective action has been taken. Ensure such action is taken and verified before re-scheduling a new start-up. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.4 in this Section.

.13 Carry-out performance checks to ensure that all equipment and systems fully functional and ready for the CA to witness formal functional performance tests (FPTs).

.14 Operate equipment and systems for FPTs in accordance with the commissioning plan and as directed by the commissioning agency. If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FPTs will be stopped by the CC. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.4 in this Section. Ensure that all corrections necessary for full and complete system operation as specified are completed; then with the ATC contractor and other applicable sub-contractors, carry out functional performance checks to confirm correct operation before applying to the CA to re-schedule the FPTs for the system in question.

.15 Prepare preliminary schedule for mechanical system orientation and inspections. O&M Manual submission, training sessions, pipe and duct system testing, flushing and cleaning, equipment start-up TAB, and task completion for use by the CA. Update schedule as appropriate throughout the construction period.

.16 Attend initial O&M staff training session.

.17 Conduct mechanical system orientation and inspection at the equipment placement completion stage.

.18 Update drawings to as-built condition and review with the CA.

.19 Gather O&M data on all equipment and assemble in binders as required by the commissioning specification. Submit to CA prior to the completion of construction.

.20 Participate in, and schedule vendors and contractors to participate in the O&M staff training sessions as set up by the CA.

.21 Provide written notification to the general contractor (or construction manager) and CA that the following work has been completed in accordance with the contract documents and the equipment, systems and sub-systems are operating as required.

.1 HVAC equipment including all fans, air handling units,

dehumidification units, ductwork, dampers, terminals, and all Division 23 equipment.

.2 Refrigeration equipment, pumping systems and heat rejection equipment.

.3 Fire-stopping in the fire-rated construction, including fire and smoke damper installation, caulking, gasketing and sealing of smoke barriers.

.4 Seismic restraints installed to specification; a certification from the seismic restraint engineer meets this requirement.

.5 Dedicated smoke control systems including stairway pressurization and atrium systems.

.6 Non-dedicated systems using the air-handling units for smoke control.

.7 Fire detection and smoke detection devices furnished under other divisions of this specification as they affect the operation of the smoke control systems.

.8 That the building control system is functioning to control HVAC equipment and smoke control systems as specified.

.22 Provide a complete set of as-built drawings and O&M manuals to the CA.

3.6 TAB AGENCY'S RESPONSIBILITIES

.1 With respect to HVAC commissioning, the TAB agency shall:

.1 Include costs for HVAC commissioning requirements in the quoted price.

.2 Attend commissioning meetings scheduled by the CA prior to , and during, on-site TAB work being done.

.3 Submit proposed TAB procedures to the CA and mechanical engineer for review and acceptance.

.4 Attend the TAB planning meeting scheduled by the CA. Be prepared to discuss the procedures that shall be followed in testing, adjusting and balancing the HVAC system.

.5 At the completion of the TAB work, submit the final TAB report to the mechanical contractor, submittal will be to the mechanical contractor, with general contractor, CA, and mechanical engineer notified

.6 Participate in verification of the TAB report by the CA for verification or diagnostic purposes. This will consist of repeating a sample (normally 10% to 20%) of the measurements contained in the TAB report as directed by the CA.

.7 Participate in O&M personnel training sessions as scheduled by the CA.

3.7 CONTROLS SUBCONTRACTOR'S RESPONSIBILITIES

.1 With respect to HVAC commissioning, the controls contractor shall:

.1 Include cost for commissioning requirements in the quoted price.

.2 Review design for controllability with respect to equipment selected for the project.

.1 Review and confirm in writing that a proper hardware specification exists to permit functional performance testing as required by specification and sequence of operation.

.2 Review and confirm in writing that proper safeties and interlocks are included in design.

.3 Ensure the proper sizing of control valves and actuators, based on design pressure drops. Ensure that control valve authority will result in capacity control as specified. Include valve sizing and authority information in submittal to Consultant.

.4 Ensure the proper sizing of control dampers. Ensure damper authority to control air flows as specified. Review and confirm in writing proper damper positioning for mixing to prevent stratification. Ensure correct actuator vs. damper movement for smooth operation. Include damper sizing, control authority and actuator selection data in submittal to mechanical engineer.

.5 Ensure the proper selection of sensor ranges and include data with submittal to mechanical engineer.

.6 Clarify all questions concerning sequences of operation with the mechanical engineer.

.3 Attend commissioning meetings scheduled by the CC.

.4 Provide the following submittals to the CC for review:

.1 Hardware and software submittals.

.2 Control panel construction shop drawings.

.3 Diagrams showing all control points, sensor locations, point names, actuators, controllers and where necessary, points of access, all superimposed on diagrams of the physical equipment.

.4 Narrative description of all control sequences for each piece of equipment controlled.

.5 Logic diagrams showing the logic flow of all control sequences.

.6 A list of all control points, including analog inputs, analog outputs, digital inputs and digital outputs. Include the values of all parameters for each system point. Provide a separate list for each stand-alone control unit.

.7 A complete control language program listing including all software routines employed in operating the control system. Also, provide a program write-up, organized in the same manner as the control software. This narrative shall describe the logic flow of the

software and the functions of each routine and sub-routine. It should also explain individual math or logic operations that are not clear from reading the software listing.

.8 Hardware operation and maintenance manuals.

.9 Application software and project applications code manuals.

.5 Inspect, check, and confirm the proper installation and performance of controls/BAS hardware and software provided by others.

.6 Integrate installation and programming scheduling with construction and commissioning schedules.

.7 Inspect, check and confirm the correct installation and operation of input and output field points and devices through documented and signed off point-to-point checkouts.

.8 Provide thorough training to operating personnel on hardware operations and programming, and the application program for the system, in accordance with the O&M staff training program in the commissioning plan.

.9 In conjunction with the mechanical contractor, demonstrate system performance to the CC including all modes of system operation (e.g. occupied, unoccupied, emergency) during the functional performance tests (FTPs). If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FPTs will be stopped by the CC. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.2 in this Section.

.10 Provide control system technician to assist during system verification and functional performance testing.

.11 Provide support and coordination with TAB contractor on all interfaces between controls and TAB scopes of work. Provide, at no additional cost to the TAB and commissioning agencies, all devices, such as portable operator's terminals and all software for the TAB agency to use in completing TAB procedures.

3.8 ELECTRICAL SUBCONTRACTOR'S RESPONSIBILITIES

.1 With respect to HVAC commissioning, the electrical contractor shall:

.1 Include cost for HVAC commissioning requirements in the quoted price.

.2 Review design with respect to providing power to the HVAC equipment:

.1 Verify that proper hardware specifications exist for functional performance and sequence of operation required by specification.

.2 Verify that proper safeties and interlocks are included in the design of electrical connections for HVAC equipment.

.3 Attend commissioning meetings scheduled by the CC.

.4 Schedule work so that required electrical installations are completed, and

systems verification checks and functional performance tests can be carried out on schedule.

.5 Inspect, check and confirm in writing the proper installation and performance of all electrical services provided.

.6 Provide electrical system technicians to assist during system verification and functional performance testing as required by the CC.

END OF SECTION

1. GENERAL

1.1 GENERAL REQUIREMENTS

.1 Refer to Section 23 01 01.

1.1 REFERENCE STANDARDS

.1 ASTM International (ASTM)

.1 ASTM E202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.2 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

.1 In accordance with Section 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems.

1.3 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 Cooling tower (and/or industrial fluid cooler) fan failure.

.9 Outdoor reset. Re-check heat exchanger output supply temperature at 100% and 50% reset, maximum water temperature.

1.4 HYDRONIC SYSTEM CAPACITY TEST

.1 Perform hydronic system capacity tests after:

.1 TAB has been completed

.2 Verification of operating, limit, 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.

.7 Chilled water system capacity test:

.1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:

.1 Adding heat from building heating system or;

.2 Raising space temperature by turning off cooling and air systems for sufficient period of time before starting testing and pre-heating building to summer design space temperature (occupied) or above. Set OAD and RAD for minimum outside air if OAT is near outside design temperature or to maximum recirculation if RAT is greater that OAT. RAT to be at least 23 degrees C minimum.

.2 Test procedures:

.1 Open fully cooling coil control valves.

.2 Set thermostats on associated AHU's for maximum cooling.

.3 Set AHU's for design maximum air flow rates.

.4 Set load or demand limiters on chillers to 100%.

.5 After system has stabilized, record chilled water, and condenser water flow rates and supply and return temperatures simultaneously.

1.5 GLYCOL SYSTEMS

.1 Test to prove concentration will prevent freezing to minus 25 degrees C Test inhibitor strength and include in procedural report. Refer to ASTM E202.

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 WET AND DRY PIPE SPRINKLER SYSTEM, STANDPIPE AND HOSE SYSTEMS

.1 Cleaning, testing, start-up, performance verification of equipment, systems, components, and devices is specified elsewhere in Division 23.

.2 Verification of controls, detection devices, alarm devices is specified Division 26.

.3 Demonstrate that fire hose will reach to most remote location regardless of partitions, and obstructions.

.4 Verify operation of interlocks between HVAC systems and fire alarm systems.

1.8 SANITARY AND STORM DRAINAGE SYSTEMS

.1 Buried systems: perform tests prior to back-filling. Perform hydraulic tests to verify grades and freedom from obstructions.

.2 Ensure that traps are fully and permanently primed.

.3 Ensure that fixtures are properly anchored, connected to system.

.4 Operate flush valves, tank and operate each fixture to verify drainage and no leakage.

.5 Cleanouts: refer to Section 22 05 15 - Plumbing Specialities and Accessories.

.6 Roof drains:

.1 Refer to Section 22 05 15 - Plumbing Specialities and Accessories.

.2 Remove caps as required.

1.9 REPORTS

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

1.10 TRAINING

.1 In accordance with Section 01 91 13 - General Commissioning Requirements: Training of O&M Personnel, supplemented as specified herein.

2. PRODUCTS

2.1 NOT USED

.1 Not Used.

3. EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 23 01 01.

1.2 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI)/American Welding Society (AWS)

.1 ANSI/AWS A5.8/A5.8M-11, AMD1 Specification Filler Metals for Brazing and Braze Welding.

.2 ASME

.1 ANSI/ASME B16.4-06, Gray-Iron Threaded Fittings Classes 125 and 250.

.2 ANSI/ASME B16.15-11, Cast Copper Alloy Threaded Fittings Classes 125 and 250.

.3 ANSI B16.18-12, Cast Copper Alloy, Solder Joint Pressure Fittings.

.4 ANSI/ASME B16.22-12, Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.

.5 ASME B31.9, Building Services Piping.

.3 ASTM International (ASTM)

.1 ASTM B32-08, Standard Specification for Solder Metal.

.2 ASTM B61-08, Standard Specification for Steam or Valve Bronze Castings.

.3 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.

.4 ASTM B88M-05(2011), Standard Specification for Seamless Copper Water Tube.

.5 ASTM E202-12, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

.4 CSA Group (CSA)

.1 CAN/CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.

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

.1 Safety Data Sheets (SDS).

.6 Manufacturers Standardization Society (MSS)

.1 MSS SP67-[2011], Butterfly Valves.

.2 MSS SP70-[2011], Cast Iron Gate Valves, Flanged and Threaded Ends.

.3 MSS SP71-[2011], Grey Iron Swing Check Valves, Flanged and Threaded Ends.

.4 MSS SP80-[2008], Bronze Gate, Globe, Angle and Check Valves.

.5 MSS SP85-[2011], Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 SHOP DRAWING 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 [hydronic systems] and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit 2 copies of WHMIS SDS in accordance with Section 01 35 29.06 - Health and Safety Requirements [01 35 43 - Environmental Procedures].

.3 Shop Drawings:

.1 Indicate on manufacturers catalogue literature the following: valves.

.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.4 CLOSEOUT SUBMITTALS

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

.2 Operation and Maintenance Data: submit operation and maintenance data for hydronic systems for incorporation into manual.

1.5 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials:

.1 Furnish following spare parts:

.1 Valve seats: one for every ten valves, each size. Minimum one.

.2 Discs: one for every ten valves, each size. Minimum one.

.3 Stem packing: one for every ten valves, each size. Minimum one.

.4 Valve handles: two of each size.

.5 Gaskets for flanges: one for every ten flanges.

1.6 QUALITY ASSURANCE

.1 Regulatory Requirements: ensure Work is performed in compliance with CEPA, CEAA, TDGA, and applicable Provincial regulations.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:

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

.2 Store and protect hydronic systems products from nicks, scratches, ,blemishes, vermin, theft and vandalism.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of 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 TUBING

.1 Type K or L hard drawn copper tubing: to ASTM B88M.

2.2 FITTINGS

.1 Cast bronze threaded fittings: to ANSI/ASME B16.15.

.2 Wrought copper and copper alloy solder joint pressure fittings: to ANSI/ASME B16.22.

.3 Cast iron threaded fittings: to ANSI/ASME B16.4.

.4 Cast copper alloy solder joint pressure fittings: to ANSI B16.18.

2.3 FLANGES

.1 Brass or bronze: threaded.

.2 Cast iron: threaded.

.3 Orifice flanges: slip-on, raised face, 2100 kPa.

2.4 JOINTS

.1 Solder, tin-antimony, 95:5: to ASTM B32.

.2 Silver solder BCUP: to ANSI/AWS A5.8.

.3 Brazing: as indicated.

2.5 VALVES

.1 Connections:

.1 NPS 2 and smaller: ends for soldering.

.2 NPS 2 1/2 and larger: flanged or grooved ends to suit piping.

.2 Gate Valves: application: isolating equipment, control valves, pipelines:

.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: application: isolating each cell or section of multiple component equipment (i.e. multi-section coils, multi-cell cooling towers):

.1 NPS 2 1/2 and over: lug type or grooved ends: as specified Section 23 05 23.05 – Valves - Butterfly.

.4 Globe valves: application: throttling, flow control, emergency bypass:

.1 NPS 2 and under:

.1 Mechanical Rooms: with PTFE disc, as specified Section 23 05 23.01 - Valves - Bronze.

.2 Elsewhere: globe, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.

.2 NPS 2 1/2 and over:

.1 With composition disc, bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.

.2 Operators: Gear.

.5 Balancing, for TAB:

.1 Sizes: calibrated balancing valves, as specified.

.2 NPS 2 and under:

.1 Mechanical rooms: globe, with plug disc as specified Section 23 05 23.01 - Valves - Bronze.

.2 Elsewhere: globe, with plug disc as specified 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 Bypass valves on gate and globe valves NPS 8 and larger: NPS 3/4, globe, with PTFE disc as specified Section 23 05 23.01 - Valves - Bronze.

.8 Swing check valves:

.1 NPS 2 and under:

.1 Class 125, swing, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.

.2 NPS 2 1/2 and over:

.1 As specified Section 23 05 23.02 - Valves – Cast Iron.

.9 Silent check valves:

.1 NPS 2 and under:

.1 As specified Section 23 05 23.01 - Valves - Bronze.

.2 NPS 2 1/2 and over:

.1 Flanged or Grooved ends: as specified Section 23 05 23.02 - Valves - Cast Iron.

.10 Ball valves:

.1 NPS 2 and under: as specified Section 23 05 23.01 - Valves - Bronze.

2.6 CIRCUIT BALANCING VALVES

.1 Circuit Balancing Valves; 2" (50 mm) and smaller:

.1 Screwed connection, globe style design, nonferrous, pressure die-cast, nonporous Ametal Copper Alloy. Each valve shall be such that when installed in any direction, it will not affect flow measurement.

.2 Provide the following functions:

.1 Precise flow measurement.

.2 Precision flow balancing.

.3 Positive shut off with no drip seat and teflon disc.

.4 Drain connection with protective cap.

.3 Four 360° adjustment turns of handwheel for maximum vernier-type setting with "Hidden Memory" feature to program the valve with precision tamper-proof balancing setting.

.4 Shipped in a 4.5 R factor polyurethane container that shall be used as insulation after valve in installed.

.5 Provide valves suitable for maximum working pressure of 250 psi (1720 kPa) and maximum operating temperature of 250°F (121°C).

.6 Acceptable Products: S.A. Armstrong CRV I indicated or Tour & Anderson STA-D or Newman Hattersley.

.2 Circuit Balancing Valves 2 1/2" (65 mm) and larger

.1 Flanged, line size connection, globe style design, nonferrous, pressure die-cast, nonporous Ametal Copper Alloy.

.2 Provide the following functions:

.1 Precise flow measurement.

.2 Precision flow balancing.

.3 Positive shut off with no drip seat and teflon disc.

.3 Twelve 360° adjustment turns of handwheel for maximum vernier-type setting with "Hidden Memory" feature to program the valve with precision tamper-proof balancing setting.

.4 Suitable for maximum working pressure of 250 psi (1720 kPa) and maximum operating temperature of 250°F (120°C).

.5 Acceptable Products: S.A. Armstrong CBV II indicated or Tour & Anderson STA-F or Newman Hattersley.

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 Consultant.
- .2 Inform Consultant 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 Consultant.

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 PREPARATION

.1 Ream pipe and tube ends, remove burrs.

.2 Remove scale and dirt on inside and outside before assembly.

.3 Prepare piping connections to equipment with flanges or unions.

.4 Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

.5 After completion, fill, clean, and treat systems.

3.4 PIPING INSTALLATION

.1 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.

.2 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping where practical.

.3 Slope piping in direction of drainage and for positive venting.

.4 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.

.5 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.

.6 Assemble piping using fittings manufactured to ANSI standards.

.7 Install heating water, glycol, chilled water, condenser water piping to CSA B51.

.8 Sleeve pipe passing through partitions, walls and floors.

.9 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

.10 Inserts:

- .1 Provide inserts for placement in concrete formwork.
- .2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- .3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4" (100 mm).
- .4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- .5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

.11 Pipe Hangers and Supports:

- .1 Install to CSA B51.
- .2 Support horizontal piping as scheduled.
- .3 Install hangers to provide minimum 1/2" (13 mm) space between finished covering and adjacent work.
- .4 Place hangers within 12" (300 mm) of each horizontal elbow.
- .5 Use hangers with 1-1/2" (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
- .6 Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
- .7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- .8 Provide copper plated hangers and supports for copper piping.
- .9 Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

.12 Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

.13 Provide access where valves and fittings are not exposed.

.14 Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

.15 Unless specified otherwise, slope piping down in the direction of flow not less than 1" in 40 feet.

.16 Provide eccentric reducers to keep the bottom of sloped piping aligned in order to minimize risk of water hammer and to facilitate drainage.

.17 Pipe discharge from temperature & pressure safety relief valves to a point of safe discharge directly into a floor drain, hub drain or safe outdoor location.

3.5 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.

.5 Fit strainers 1-1/2" (38mm) & larger with blow down valves.

3.6 EQUIPMENT CONNECTIONS

.1 Install unions or flanges at connections to equipment and specialty components.

.2 Arrange piping connections to allow ease of access and removal of equipment.

.3 Align and independently support piping adjacent to equipment connections to prevent piping stresses from being transferred to equipment.

.4 Provide piping reducers where equipment connections differ from pipe sizes indicated. Do not use bushings.

.5 Install removable sections of pipe 12" (300 mm) (spool pieces) on the suction side of pumps and where needed for ease of maintenance.

3.7 VALVES, COCKS, AND FAUCETS

.1 Use valves of line size unless noted otherwise.

.2 Provide isolating valves in each branch from the main line and where indicated.

.3 Provide isolating valves at equipment connections.

.4 Provide globe valves or ball valves complete with memory stop at the discharge of each pump and where valves are used for regulating or throttling purposes.

.5 Provide 1/2" (13 mm) brass hose bibbs at all low points of each system, where the system cannot be drained through the main floor or return piping.

.6 Where new valves are installed to replace existing valves and it is impractical to shut down and drain the entire system, replace valves using pipe freezing techniques.

3.8 VALVE INSTALLATION

.1 Install rising stem valves in upright position with stem above horizontal.

.2 Install butterfly valves on chilled water and condenser water lines only.

.3 Install gate, ball or butterfly valves at branch take-offs and to isolate each piece of equipment, and as indicated.

.4 Install globe valves for balancing and in by-pass around control valves as indicated.

.5 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.

.6 Install swing check valves in horizontal lines on discharge of pumps and as indicated.

.7 Install chain operators on valves NPS 2 1/2 and over where installed more than 2400 mm above floor in Boiler Rooms and Mechanical Equipment Rooms.

.8 Install plug cocks or ball valves for glycol service.

3.9 CIRCUIT BALANCING VALVES

.1 Install flow measuring stations and flow balancing valves as indicated.

.2 Remove handwheel after installation and TAB is complete.

.3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.10 FLUSHING AND CLEANING

.1 Flush and clean in presence of Consultant.

.2 Flush after pressure test for a minimum of 4 hours.

.3 Fill with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8 hours.

.4 Refill system with clean water. Circulate for at least 4 hours. Clean out strainer screens/baskets regularly. Then drain.

.5 Refill system with clean water. Circulate for at least 2 hours. Clean out strainer screens/baskets regularly. Then drain.

.6 Drainage to include drain valves, dirt pockets, strainers, low points in system.

.7 Re-install strainer screens/baskets only after obtaining Consultant’s approval.

3.11 FILLING OF SYSTEM

.1 Refill system with clean water adding water treatment as specified or glycol as specified.

3.12 FIELD QUALITY CONTROL

.1 Testing:

.1 Test system in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 For glycol systems, retest with glycol to ASTM E202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.

.2 Balancing:

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

.2 Refer to Section 23 05 93.

.3 Glycol Charging:

.1 Provide mixing tank and positive displacement pump for glycol charging.

.2 Retest for concentration to ASTM E202 after cleaning.

.3 Provide report to Consultant for review.

3.13 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.

3.14 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 RELATED REQUIREMENTS

.1 Section 23 01 01.

.2 Section 23 05 17.

1.2 REFERENCE STANDARDS

.1 American National Standards Institute/American Water Works Association (ANSI/AWWA)

.1 ANSI/AWWA C111/A21.11-06, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.2 American Society of Mechanical Engineers (ASME)

.1 ASME B16.1-10, Grey Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

.2 ASME B16.3-06, Malleable Iron Threaded Fittings: Classes 150 and 300.

.3 ASME B16.5-09, Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard.

.4 ASME B16.9-07, Factory-Made Wrought Buttwelding Fittings.

.5 ASME B18.2.1-10, Square Hex, Heavy Hex and Askew Head Bolts and Hex, Heavy Hex, Hex Flange. Loded Head and Lag Screws (Inch Series).

.6 ASME B18.2.2-10, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).

.7 ASME B31.9, Building Services Piping.

.3 ASTM International (ASTM)

.1 ASTM A47/A47M-99(2009), Standard Specification for Ferritic Malleable Iron Castings.

.2 ASTM A53/A53M-10, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.

.3 ASTM A536-84(2009), Standard Specification for Ductile Iron Castings.

.4 ASTM B61-08, Standard Specification for Steam or Valve Bronze Castings.

.5 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.

.6 ASTM E202-10, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.

.4 CSA Group (CSA)

.1 CSA B242-05(R2011), Groove and Shoulder Type Mechanical Pipe Couplings.

.2 CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding.

.3 CAN/CSA-B214-12, Installation Code for Hydronic Heating Systems.

.4 CAN/CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.

.5 Manufacturer's Standardization of the Valve and Fittings Industry (MSS)

.1 MSS-SP-67-2002a, 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-80-08, Bronze Gate, Globe, Angle and Check Valves.

.5 MSS-SP-85-02, Grey Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 SHOP DRAWING 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 hydronic systems and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Indicate on drawings:

.1 Components and accessories.

1.4 CLOSEOUT SUBMITTALS

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

.2 Operation and Maintenance Data: submit operation and maintenance data for hydronic systems for incorporation into manual.

.1 Include special servicing requirements.

1.5 EXTRA STOCK MATERIALS

.1 Supply spare parts as follows:

.1 Valve seats: one for every ten valves, each size. Minimum one.

.2 Discs: one for every ten valves, each size. Minimum one.

.3 Stem packing: one for every ten valves, each size. Minimum one.

.4 Valve handles: two minimum of each size.

.5 Gaskets for flanges: one minimum for every ten flanges.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:

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

.2 Store and protect hydronic systems from nicks, scratches, theft, vandalism and vermin.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials as specified in Construction Waste Management Plan Waste Reduction Workplan in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 PIPE

.1 Steel pipe: to ASTM A53B, ERW or A106B as follows:

.1 To NPS 10: Schedule 40.

.2 NPS 12 and over, Sch STD

2.2 PIPE JOINTS

.1 NPS 2 and under: screwed fittings with PTFE tape or lead-free pipe dope.

.2 NPS 2-1/2 and over: welding fittings and flanges to CSA W48.

.3 Roll grooved: standard or rigid coupling to CSA B242.

.4 Flanges: raised face, slip-on or weld neck ASTM B16.5.

.5 Orifice flanges: slip-on raised face, 2100 kPa.

.6 Flange gaskets: to ASTM B16.5

.7 Pipe thread: taper.

.8 Bolts and nuts: to ASME B18.2.1 and ASME B18.2.2.

.9 Roll grooved coupling gaskets: type EPDM.

2.3 FITTINGS

.1 Screwed fittings: malleable iron, to ASME B16.3, Class 150.

.2 Pipe flanges and flanged fittings:

.1 Cast iron: to ASME B16.1, Class 125.

.2 Steel: to ASME B16.5.

.3 Butt-welding fittings: steel, to ASME B16.9.

.4 Unions: malleable iron, to ASTM A47/A47M and ASME B16.3.

.5 Fittings for roll grooved piping: ductile iron to ASTM A536.

2.4 VALVES

.1 Connections:

.1 NPS 2 and smaller: screwed ends.

.2 NPS 2-1/2 and larger: flanged or grooved ends to suit piping.

.2 Gate valves: to MSS-SP-70 or 80, application: isolating equipment, control valves, pipelines:

.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, lead free bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.

.2 Elsewhere: non-rising stem, solid wedge disc, lead free bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.

.3 Butterfly valves: to MSS-SP-67 application: isolating cells or section of multiple component equipment (i.e. multi-section coils, multi-cell cooling towers)]:

.1 NPS 2-1/2 and over: lug type: as specified Section 23 05 17 - Pipe Welding.

.4 Globe valves: to MSS-SP-80 or 85 application: throttling, flow control, emergency bypass:

.1 NPS 2 and under:

.1 Mechanical Rooms: with PTFE disc, as specified Section 23 05 23.01 - Valves - Bronze.

.2 Elsewhere: globe, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.

.2 NPS 2-1/2 and over:

.1 With lead free bronze disc, lead free bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.

.2 Operators: Gear.

.5 Balancing, for TAB:

.1 Sizes: calibrated balancing valves, as specified this section.

.2 NPS 2 and under:

.1 Mechanical Rooms: globe, with plug disc as specified Section 23 05 23.01 - Valves - Bronze.

.2 Elsewhere: globe, with plug disc as specified 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 Bypass valves on valves NPS 8 and larger: NPS 3/4, Globe, with PTFE disc as specified Section 23 05 23.01 - Valves - Bronze.

.8 Swing check valves: to MSS-SP-71.

.1 NPS 2 and under:

.1 Class 125, swing, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.

.2 NPS 2-1/2 and over:

.1 Flanged ends: as specified Section 23 05 23.02 - Valves - Cast Iron.

.9 Silent check valves:

.1 NPS 2 and under:

.1 As specified Section 23 05 23.01 - Valves - Bronze.

.2 NPS 2-1/2 and over:

.1 Flanged ends: as specified Section 23 05 23.02 - Valves - Cast Iron.

.10 Ball valves:

.1 NPS 2 and under: as specified Section 23 05 23.01 - Valves - Bronze.

2.5 CIRCUIT BALANCING VALVES

.1 Circuit Balancing Valves; 2" (50 mm) and smaller:

.1 Screwed connection, globe style design, nonferrous, pressure die-cast, nonporous Ametal Copper Alloy. Each valve shall be such that when installed in any direction, it will not affect flow measurement.

.2 Provide the following functions:

.1 Precise flow measurement.

.2 Precision flow balancing.

.3 Positive shut off with no drip seat and teflon disc.

.4 Drain connection with protective cap.

.3 Four 360° adjustment turns of handwheel for maximum vernier-type setting with "Hidden Memory" feature to program the valve with precision tamper-proof balancing setting.

.4 Shipped in a 4.5 R factor polyurethane container that shall be used as insulation after valve in installed.

.5 Provide valves suitable for maximum working pressure of 250 psi (1720 kPa) and maximum operating temperature of 250°F (121°C).

.6 Acceptable Products: S.A. Armstrong CRV I indicated or Tour & Anderson STA-D or Newman Hattersley.

.2 Circuit Balancing Valves 2 1/2" (65 mm) and larger

.1 Flanged, line size connection, globe style design, nonferrous, pressure die-cast, nonporous Ametal Copper Alloy.

.2 Provide the following functions:

.1 Precise flow measurement.

.2 Precision flow balancing.

.3 Positive shut off with no drip seat and teflon disc.

.3 Twelve 360° adjustment turns of handwheel for maximum vernier-type setting with "Hidden Memory" feature to program the valve with precision tamper-proof balancing setting.

.4 Suitable for maximum working pressure of 250 psi (1720 kPa) and maximum operating temperature of 250°F (120°C).

.5 Acceptable Products: S.A. Armstrong CBV II indicated or Tour & Anderson STA-F or Newman Hattersley.

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 Consultant.

.2 Inform Consultant 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 Consultant.

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 PREPARATION

.1 Ream pipe and tube ends, remove burrs.

.2 Remove scale and dirt on inside and outside before assembly.

.3 Prepare piping connections to equipment with flanges or unions.

.4 Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

.5 After completion, fill, clean, and treat systems.

3.4 PIPING INSTALLATION

.1 Install pipework in accordance with Section 23 05 15 - Common Installation Requirements for HVAC Pipework.

.2 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.

.3 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping where practical.

.4 Slope piping in direction of drainage and for positive venting.

.5 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.

.6 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.

.7 Assemble piping using fittings manufactured to ANSI standards.

.8 Install heating water, glycol, chilled water, condenser water piping to CSA B51.

.9 Sleeve pipe passing through partitions, walls and floors.

.10 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

.11 Inserts:

.1 Provide inserts for placement in concrete formwork.

.2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

.3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4" (100 mm).

.4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

.5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

.12 Pipe Hangers and Supports:

.1 Install to CSA B51.

.2 Support horizontal piping as scheduled.

.3 Install hangers to provide minimum 1/2" (13 mm) space between finished covering and adjacent work.

.4 Place hangers within 12" (300 mm) of each horizontal elbow.

.5 Use hangers with 1-1/2" (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

.6 Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.

.7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

.8 Provide copper plated hangers and supports for copper piping.

.9 Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

.13 Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

.14 Provide access where valves and fittings are not exposed.

.15 Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

.16 Unless specified otherwise, slope piping down in the direction of flow not less than 1" in 40 feet.

.17 Provide eccentric reducers to keep the bottom of sloped piping aligned in order to minimize risk of water hammer and to facilitate drainage.

.18 Pipe discharge from temperature & pressure safety relief valves to a point of safe discharge directly into a floor drain, hub drain or safe outdoor location.

3.5 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.

.5 Fit strainers 1-1/2" (38mm) & larger with blow down valves.

3.6 EQUIPMENT CONNECTIONS

.1 Install unions or flanges at connections to equipment and specialty components.

.2 Arrange piping connections to allow ease of access and removal of equipment.

.3 Align and independently support piping adjacent to equipment connections to prevent piping stresses from being transferred to equipment.

.4 Provide piping reducers where equipment connections differ from pipe sizes indicated. Do not use bushings.

.5 Install removable sections of pipe 12" (300 mm) (spool pieces) on the suction side of pumps and where needed for ease of maintenance.

3.7 VALVES, COCKS, AND FAUCETS

.1 Use valves of line size unless noted otherwise.

.2 Provide isolating valves in each branch from the main line and where indicated.

.3 Provide isolating valves at equipment connections.

.4 Provide globe valves or ball valves complete with memory stop at the discharge of each pump and where valves are used for regulating or throttling purposes.

.5 Provide 1/2" (13 mm) brass hose bibbs at all low points of each system, where the system cannot be drained through the main floor or return piping.

.6 Where new valves are installed to replace existing valves and it is impractical to shut down and drain the entire system, replace valves using pipe freezing techniques.

3.8 VALVE INSTALLATION

.1 Install rising stem valves in upright position with stem above horizontal.

.2 Install butterfly valves on chilled water and condenser water lines only.

.3 Install gate, ball or butterfly valves at branch take-offs and to isolate each piece of equipment, and as indicated.

.4 Install globe valves for balancing and in by-pass around control valves as indicated.

.5 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.

.6 Install swing check valves in horizontal lines on discharge of pumps and as indicated.

.7 Install chain operators on valves NPS 2 1/2 and over where installed more than 2400 mm above floor in Boiler Rooms and Mechanical Equipment Rooms.

.8 Install plug cocks or ball valves for glycol service.

3.9 CIRCUIT BALANCING VALVES

.1 Install flow measuring stations and flow balancing valves as indicated.

.2 Remove handwheel after installation and when TAB is complete.

.3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.10 CLEANING, FLUSHING AND START-UP

.1 In accordance with Section 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems.

3.11 TESTING

.1 Test system in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 For glycol systems, retest with glycol to ASTM E202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.

3.12 BALANCING

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

.2 In accordance with Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for applicable procedures.

3.13 GLYCOL CHARGING

.1 Include mixing tank and positive displacement pump for glycol charging.

.2 Retest for concentration to ASTM E202 after cleaning.

3.14 PERFORMANCE VERIFICATION

.1 In accordance with Section 23 08 13 - Performance Verification HVAC Systems.

3.15 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 [01 35 21 - LEED Requirements].

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

3.16 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

1. GENERAL

1.1 GENERAL REQUIREMENTS

.1 Refer to Section 23 01 01.

.2 Refer to Section 23 05 15.

.3 Refer to Section 23 21 13.

1.1 REFERENCE STANDARDS

.1 ASME

.1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII-2013.

.2 ASTM International (ASTM)

.1 ASTM A47/A47M-99(2009), Standard Specification for Ferritic Malleable Iron Castings.

.2 ASTM A278/A278M-01(2011), Standard Specification for Grey Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (350 degrees C).

.3 ASTM A516/A516M-10, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.

.4 ASTM A536-84(2009), Standard Specification for Ductile Iron Castings.

.5 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.

.3 CSA Group (CSA)

.1 CSA B51-09, 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 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for expansion tanks, air vents, separators, valves, and strainers and include product characteristics, performance criteria, physical size, finish and limitations.

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 hydronic specialties for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area free from vermin and protected against theft and vandalism.

.2 Store and protect hydronic specialties from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

2. PRODUCTS

2.1 CLOSED EXPANSION TANK

.1 Horizontal expansion tank with threaded pipe connections.

.2 Capacity: as indicated.

.3 Size: as indicated.

.4 Construction:

.1 ASME code rated welded tank to 860 kPa test pressure of ASTM A516/A516M, pressure vessel carbon steel plate with dished heads galvanized after manufacture.

.2 Conform to: ASME BPVC, Section VII and CSA B51, and provincial regulations.

.3 Submit certificate of registration as required by provincial authorities.

.5 Accessories:

.1 Expansion pipe connection at bottom.

.2 Circulating pipe connection at bottom.

.3 NPS 1 drain connection at bottom with drain valve.

.4 Vent connection at top.

.5 Relief valve and connection at top, to manufacturer's recommendations.

.6 Service hole - 275 x 375 mm on end.

.7 12 mm sight glass connections at 1/8 and 7/8 points of height, complete with sight glass, shut-off valves with blowdown and protective guards.

.8 Two - 62 mm inspection tappings on centre line of sides, one near each end.

.6 Supports: provide supports with hold down bolts and installation templates incorporating seismic restraint systems as required.

2.2 DIAPHRAGM TYPE EXPANSION TANK

.1 Steel pressurized diaphragm type expansion tank.

.2 Capacity: as indicated.

.3 Size: as indicated.

.4 Diaphragm sealed in EPDM suitable for 115 degrees C operating temperature.

.5 Working pressure: 860 kPa with ASME stamp and certification.

.6 Air precharged to initial fill pressure of system.

.7 Base mount for vertical installation.

.8 Supports: provide supports with hold down bolts and installation templates incorporating seismic restraint system as required.

.9 Renewable diaphragm.

2.3 AUTOMATIC AIR VENT

.1 Standard float vent: brass body and NPS 1/8 connection and rated at 690 kPa working pressure.

.2 Industrial float vent: cast iron body and NPS 1/2 connection and rated at 860 kPa working pressure.

.3 Float: solid material suitable for 115 degrees C working temperature.

2.4 AIR SEPARATOR - IN-LINE

.1 Working pressure: 860 kPa.

.2 Size: as indicated.

2.5 COMBINATION SEPARATORS/STRAINERS

.1 Steel, tested and stamped in accordance with ASME BPVC, for 860 kPa operating pressure, with galvanized steel integral strainer with 5 mm perforations, tangential inlet and outlet connections, and internal stainless steel air collector tube.

2.6 COMBINATION LOW PRESSURE RELIEF AND REDUCING VALVE

.1 Adjustable pressure setting: 206 kPa relief, 55 to 172 kPa reducing.

.2 Low inlet pressure check valve.

.3 Removable strainer.

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 specialties installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

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

3.2 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and data sheets.

3.3 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 Consultant’s directive.

.4 Check shop drawings for conformance of tappings for ancillaries and for equipment operating weights.

3.4 AIR VENTS

.1 Install at high points of systems.

.2 Install ball valve on automatic air vent inlet. Run discharge to nearest drain or service sink.

.3 Select air vents to suit the system operating pressures.

3.5 EXPANSION TANKS

.1 Adjust expansion tank pressure to suit design criteria.

.2 Install lockshield type valve at inlet to tank.

3.6 PRESSURE SAFETY RELIEF VALVES

.1 Run discharge pipe to terminate above nearest drain.

3.7 SUCTION DIFFUSERS

.1 Install on inlet to pumps having suction size greater than 50.

3.8 CLEANING

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

.1 Leave Work area clean at end of each day.

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

.3 Waste Management: separate waste materials for reuse and recycling 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

1. GENERAL

1.1 GENERAL REQUIREMENTS

.1 Refer to Section 23 01 01.

1.1 REFERENCE STANDARDS

.1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)

.1 ANSI/ASHRAE/IES Standard 90.1-2013, Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME).

.1 ANSI/ASME B16.5-2009, Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard.

.3 American National Standards Institute/International Electrical Commission (ANSI/IEC).

.1 IEC 60529- 2004, Degrees of Protection Provided by Enclosures (IP Code).

.4 ASTM International (ASTM).

.1 ASTM A48/A48M-2003 (2008), Standard Specification for Gray Iron Castings.

.2 ASTM A536-1984 (2009), Standard Specification for Ductile Iron Castings.

.3 ASTM A582/A582M-2005, Standard Specification for Free-Machining Stainless Steel Bars.

.4 ASTM B584-2011, Standard Specification for Copper Alloy Sand Castings for General Applications.

.5 ASTM A743 CF8M Standard Specification for Type 316 Stainless Steel Castings.

.6 ASTM A351 CF8M Standard Specification for Type 316 Stainless Steel Bars

.5 CSA Group (CSA)

.1 CAN/CSA-B214-12, Installation Code for Hydronic Heating Systems.

.2 CAN/CSA C22.2 No.108-2001 (R2010), Liquid Pumps.

.6 Electrical Equipment Manufacturers Association of Canada (EEMAC)

.7 German Institute for Standardization (DIN).

.1 DIN EN 61800-3- 2004, Adjustable Speed Electrical Power Drive Systems - Part 3: EMC Requirements and Specific Test Methods.

.8 Institute of Electrical and Electronics Engineers (IEEE).

.1 IEEE 519- 1992, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.

.9 National Electrical and Manufacturers Association (NEMA).

.1 NEMA MG-1 Standard-2011, Motors and Generators, Revision 1.

.10 Underwriter's Laboratories (UL).

.1 UL 778-2011, Motor-Operated Water Pumps.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data

.1 Submit product data including manufacturer's literature for hydronic pump, controls, components and accessories, indicating compliance with specified requirements and material characteristics.

.2 Submit list on pump manufacturer's letterhead of materials, components and accessories to be incorporated into Work.

.3 Include pump performance curves indication where project pumps appear in curve range with pre-defined performance envelope showing optimum efficiency region.

.4 Include product names, types and series numbers.

.5 Include contact information for manufacturer and their representative for this Project.

.1 Include information on costs for wiring of pump to motor, and wiring pump mounted (internal/external) or remotely mounted differential pressure sensor(s). Also include costs for piping and commissioning of differential pressure sensor(s).

.3 Shop Drawings:

.1 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.

.2 Show pump and control enclosure dimensions on shop drawings.

.4 Test Reports:

.1 Submit test reports with each Design Envelope pump showing compliance with specified performance characteristics and physical properties including structural performance by conducting a vibration sweep over the speed range, while still in the test rig piping.

.2 Test reports shall also detail the accuracy of the controls flow and head readout, compared with the test rig calibrated instruments.

.5 Field Reports: Submit manufacturer's field reports within 3 days of each manufacturer representative's site visit and inspection.

.6 Installer Qualifications:

.1 Submit verification of manufacturer's approval of installer.

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 hydronic pumps for incorporation into manual.

.1 List materials used in hydronic pump work.

.2 Include marked up performance curves for each pump.

1.4 QUALITY ASSURANCE

.1 Provide pump and controls integrated by the manufacturer in the factory, including assembly, wiring, programming and testing. Ensure sensorless data, is mapped in the integrated controls using tested performance measurements for each specific pump. Ensure actual flow reading on site is to be available digitally for the BMS and on the controls local touchscreen. The use of catalog data for Sensorless data mapping will not be acceptable.

.2 The complete pump and control package shall be Underwriter's Laboratories listed and carry UL778 approval

.3 Provide bronze body or stainless steel T316 units NSF/ANSI 61 & 372 listed and labeled for potable water pumps.

.4 Provide test report with pumps shipped to site containing:

.1 Test compliance with specified performance characteristics and physical properties including structural performance by conducting a vibration sweep over the speed range, while still in the test rig piping.

.2 Accuracy of the controls flow and head readout, compared with the test rig calibrated instruments.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.1 Include manufacturer's name, job number, pump location, and pump model and series numbers on identification labels.

.3 Storage and Handling Requirements:

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

.2 Store and protect hydronic pumps from nicks, scratches, blemishes, vermin, theft and vandalism.

.3 Exercise care to avoid damage during unloading and storing.

.4 Leave pump port protection plates in place until pumps are ready to connect to piping.

.5 Do not place cable slings around pump shaft or integrated control enclosure.

.6 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer] of packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

2. PRODUCTS

2.1 EQUIPMENT

.1 Size and select components to: CAN/CSA-B214.

2.2 VERTICAL IN-LINE CIRCULATORS

.1 Volute: cast iron radially split, with tapped openings for venting, draining and gauge connections, with screwed or flanged suction and discharge connections.

.2 Impeller: corrosion resistant steel or cast iron.

.3 Shaft: alloy steel or stainless steel with bronze sleeve bearing, integral thrust collar.

.4 Seal assembly: mechanical for service to 135°C.

.5 Coupling: flexible self-aligning.

.6 Motor: to NEMA MG 1 resilient mounted, drip proof, sleeve bearing,

.7 Capacity: as indicated

.8 Design pressure: 1200 kPa.

2.3 VERTICAL INLINE DESIGN PUMP WITH INTEGRATED INTELLIGENT CONTROLS.

.1 Seals: serviceable without disturbing the piping connections and motor

.2 Include casing drain plug and ¼ inch suction and discharge gauge ports.

.3 Design Criteria

.1 Design pump for variable flow applications and selected for hydraulic design conditions and minimum system pressure with sensorless load Demand Based control unless otherwise specified.

.2 Select hydraulic design conditions and minimum pressure with sensorless load control unless otherwise specified.

.3 For Sensorless control ensure the operating control curve is quadratic with adjustable minimum head setting.

.4 Meet or exceed energy saving requirements of ASHRAE 90.1-2013 by pump selection, based on optimum performance at part load, to save 70% of design flow energy at 50% part-load

.5 Design pumping units to UL STD 778 & CSA STD C22.2 No.108

.6 Design Stainless Steel Type 316 units to NSF/ANSI 61 & 372

.4 Materials

.1 Casing:

.1 Class 150 - Ductile iron ASTM A536 Grade 65-45-12, e-coated.

.2 Stainless Steel ASTM A743 CF8M as noted.

.3 Test casing to 150 % maximum working pressure.

.4 Ensure casing is radially split to allow for removal of rotating element without disturbing pipe connections.

.5 Cast iron casing wetted surfaces shall be e-coated to prevent seizing of impeller to casing after periods of inactivity.

.6 Drill and tap casing for gauge ports on both suction and discharge connections.

.7 Drill and tap casing at lowest point for drain port.

.2 Impeller: To ASTM A743 CF8M, Stainless Steel Type 316, fully enclosed and dynamically balanced to ANSI G6.3 and fitted to shaft with key. Use two-plane balancing when installed impeller diameter is less than 6 times impeller width.

.3 Pump Shafts:

.1 Split-coupled: Stainless steel to ASTM A582/A582M, Grade 416.

.2 Close-coupled: Steel motor shaft with Stub Shaft: Stainless steel to ASTM A276, Type 316

.3 Stainless steel pumps: Steel motor shaft with Stainless steel pump shaft to ASTM A351 CF8M Type 316

.4 Flanges: To ANSI/ASME B16.5, Class 125.

.5 Flush Line: 3/8 inch braided stainless steel complete with vent.

.6 Casing O-ring: EPDM.

.7 Mechanical Seal: Non-potable, Type 2A inside single spring seal design and rated to 200°F maximum

.1 Rotating face: Sintered Silicon Carbide

.2 Stationary face: Sintered Silicon Carbide

.3 Seal rotating hardware: Stainless Steel

.4 Secondary / shaft seal elastomer: EPDM

.5 Electric Motors

.1 Permanent Magnet Motor: To IE5 efficiency

.2 Enclosure: TEFC.

.3 Efficiency: IE5 efficiency To IEC 60034-30-1

.6 Pump Controls

.1 Control: Integrated with UL type 12 minimum enclosure rating, sensorless controls complete with fused disconnect switch and menu-driven graphical touchscreen interface.

.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.

.3 Minimum system pressure to be maintained: 40% of design head unless otherwise specified.

.4 Orientation: L5

.1 Provide L6 orientation if required because of interference with other equipment. Co-ordinate location of seal flush line.

.5 Protocol: BACnet™ MS/TP, BACnet™ TCP/IP or Modbus RTU to suit BAS requirements.

.6 Provide sensorless override for BAS/BMS control signal.

.7 Provide manual pump control and closed loop PID control.

.8 Enclosure: UL Type 12. Provide 4X in areas subject to weather or non-dry locations.

.9 EMI/RFI Control: Integrated filter designed to DIN EN61800-3.

.10 Harmonic suppression: Equivalent 5% impedance AC line reactor) to mitigate harmonics to support IEEE 519 system requirements.

.11 Cooling: Fan cooled, surface cooling.

.12 Ambient working conditions: [14°F to +113°F], up to [3300] feet above sea level. Refer to I&O Manual for specific temperature rating by frame size.

.13 Analog I/O: 2 inputs minimum, 1 output minimum. Output can be configured for voltage or current.

.14 Digital I/O: 2 inputs minimum, 2 outputs minimum. Outputs can be configured as inputs.

.15 Pulse inputs: 2 programmable minimum.

.16 Relay outputs: 2 programmable minimum.

.17 Communications ports: 1- RS485.

.18 One volt free contact.

.19 Auto alarm reset.

.7 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).

.1 Ensure head reduction with reducing flow conforms to quadratic control curve.

.2 Head at zero flow: 40% minimum of design duty head.

.2 Linear or Proportional Pressure Control without sensor is unacceptable.

.3 Ensure control mode setting and minimum/maximum head set points are user adjustable using built-in programming interface.

.4 Ensure integrated control software is capable of controlling pump performance for non-overloading power at every point of operation.

.5 Ensure integrated control software is capable of flow rate display and data output of ± 5% accuracy to BAS/BMS.

.6 Ensure the controls can display and digitally transmit real-time flow & values

.7 Include energy monitoring log function to ASHRAE 189.1P.

.8 For multiple pump configuration ensure parallel Sensorless pump control with best efficiency staging is applied unless otherwise specified.

.9 Parallel pump staging will be provided without the use of BAS / BMS and speed / frequency based staging shall not be acceptable and a locally mounted logic controller shall be used for best efficiency staging of up to 4 parallel pumps.

.10 Parallel pump speed control shall be achieved without the need for differential pressure sensors either in the mechanical room or remotely installed in the system.

.11 The Parallel Sensorless Pump Controller will have in-built redundancy features including:

.1 ‘Daisy-chained’ power connection to each pump controller

.2 Controller ‘offline’ operational protection preventing loss of system flow

.12 Dual Season Setup

.1 Cooling Design Flow: as indicated.

.2 Cooling Design Head: as indicated.

.3 Cooling minimum system pressure to be maintained: as indicated.

.4 Heating Design Flow: as indicated.

.5 Heating Design Head: as indicated.

.6 Heating minimum system pressure to be maintained: as indicated.

.8 Pump Motor and Controls Protection

.1 Include protection as follows:

.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

.2 Ensure controls run automatic motor adaptation (AMA) for superior motor protection and control.

.9 Fabrication

.1 Install integrated controls on each pump for use with BAS/BMS for energy logging to ASHRAE 189.1P.

.2 Pre-program integrated intelligent controls for each pump before pump leaves factory.

.3 Install flush / vent line in factory.

.1 Ensure flush / vent line runs from seal chamber to [pump discharge] [pump suction].

.4 Mark pumps and controls with coordinated identification.

.10 Accessories

.1 Pipe Flanges: To ANSI/ASME B16.5, Class 150 or 300 as indicated.

.2 Hangers and Supports: in accordance with Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

.3 Vibration isolators, neoprene isolation pads in accordance with Section 23 05 48 – Vibration and Seismic Controls for HVAC.

.4 Seismic restraint in accordance with Section 23 05 48 – Vibration and Seismic Controls for HVAC.

.5 Suction Diffuser: suitable for flanged or grooved connections as required.

.6 Triple Duty Valve: Ductile iron valve body, tight shut-off, spring -closure type silent non-slam check valve with effective throttling design capability.

.1 Valve stem: Stainless steel with flat surfaces for adjustment with open-end wrench.

.2 Acceptable Material: ARMSTRONG, Model FTV Flo-Trex Combination Valve.

.7 Pressure Gauges: 4½ inch diameter sized to meet system pressure requirements.

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 pump installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

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

3.2 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and data sheets.

3.3 INSTALLERS

.1 Use only installers with 2 years minimum experience in work similar to work of this Section.

3.4 PREPARATION

.1 Weld pipe flanges to piping system for installation of pump.

.2 Ensure suction and discharge pipe flanges are aligned and square to pipe.

3.5 FIELD QUALITY CONTROL

.1 Field Inspection: Coordinate field inspection in accordance with Section 01 45 00 Quality Control.

.2 Manufacturer's Services:

.1 Coordinate manufacturer's services with Section 01 45 00 - Quality Control.

.1 Have manufacturer review work involved in handling, installation, protection, and cleaning of hydronic pumps and components, and submit written reports in acceptable format to verify compliance of Work with Contract conditions.

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

.1 Report any inconsistencies from manufacturer's recommendations immediately to Consultant.

.3 Schedule site visits to review work at stages listed:

.1 After delivery and storage of pumps, controls and components, and when preparatory work on which Work of this Section depends is complete, but before installation begins.

.2 Upon completion of Work, after cleaning is carried out.

.3 Obtain reports within three days of review and submit immediately to Consultant.

3.6 INSTALLATION

.1 Install hydronic pumps to: CAN/CSA-B214.

.2 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.

.3 Base mounted type: supply templates for anchor bolt placement.

.1 Include anchor bolts with sleeves. Place level, shim unit and grout.

.2 Align coupling in accordance with manufacturer's recommended tolerance.

.3 Check oil level and lubricate. After run-in, tighten glands.

.4 Ensure that pump body does not support piping or equipment.

.1 Provide stanchions or hangers for this purpose.

.2 Refer to manufacturer's installation instructions for details.

.5 Pipe drain tapping to floor drain.

.6 Install volute venting pet cock in accessible location.

.7 Check rotation prior to start-up. Do not run pumps dry to check rotation.

.8 Install pressure gauge test cocks.

.9 Install pumps level in accordance with pump manufacturer's written recommendations

.10 Ensure that pump is pipe-mounted and free to float with any movement, expansion and contraction of piping system.

.1 Support pump using floor mounted saddle as required.

.2 For vertical in-line pumps supported from structure, ensure no pipe strain is imposed on pump flanges.

.3 Use vibration isolators, neoprene isolation pads to meet project conditions in accordance with Section 23 05 48 – Vibration and Seismic Controls for HVAC.

.4 Use seismic restraint to meet project conditions in accordance with Section 23 05 48 – Vibration and Seismic Controls for HVAC

.5 Where pumps are supported entirely by piping system ensure hangers are sized for extra load of pump weight.

.11 Install Flo-Trex valve 180Deg - Straight after recommended length (2D min) of spool piece on discharge connection from pump.

.12 Install suction guides on pump suction connection.

.13 Install pressure gauges on suction and discharge pump connections.

.14 Install hangers and supports in accordance with Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

.1 Adjust hangers and supports after pump is installed to ensure proper support.

.15 Align pipe flanges with pump flanges and bolt together in accordance with pump manufacturer's written recommendations.

.16 Connect pumps and integrated control system to electrical distribution system to IEEE regulations and with authority having jurisdiction in accordance with Section 26 05 00 – Common Work Results for Electrical.

.1 Include wiring to most remote sensor in system where applicable.

3.7 START-UP

.1 General:

.1 In accordance with Section 01 91 13 - General Commissioning Requirements: General Requirements; supplemented as specified herein.

.2 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, 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, 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.

.15 Verify lubricating oil levels.

3.8 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 Consultant 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).

3.9 COMMISSIONING

.1 Validate alignment, rotation, motor current draw, flows and pressures in accordance with Section 23 08 00 – Commissioning of HVAC.

.2 Provide on-site commissioning of Design Envelope Pumps and Pump Manager

3.10 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.

END OF SECTION

1. GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 23 01 01.

1.2 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B16.22, Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.

.2 ASME B16.24, Cast Copper Pipe Flanges and Flanged Fittings: Class 150, 300, 600, 900, 1500 and 2500.

.3 ASME B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.

.4 ASME B31.5, Refrigeration Piping and Heat Transfer Components.

.2 ASTM International (ASTM)

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

.2 ASTM B280, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

.3 CSA Group (CSA)

.1 CSA B52 - Package, Mechanical Refrigeration Code.

.4 Environment Canada (EC)

.1 EPS 1/RA/1, Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

1.3 SHOP DRAWING 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 refrigerant piping, fittings and equipment and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit WHMIS SDS in accordance with Section 01 35 29.06 - Health and Safety Requirements Indicate VOC's for adhesive and solvents during application and curing.

.3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.4 CLOSEOUT SUBMITTALS

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

.2 Operation and Maintenance Data: submit operation and maintenance data for refrigerant piping for incorporation into manual.

.3 Submit operation and maintenance manual.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:

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

.2 Store and protect refrigerant piping, fittings and equipment from nicks, scratches, blemishes, theft, vermin and vandalism.

.3 Replace defective or damaged materials with new.

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

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 2070 kPa and temperature 121 degrees C.

.2 Brazed:

.1 Fittings: wrought copper to ASME B16.22.

.2 Joints: silver solder, 15% Ag-80% Cu-5%P or copper-phosphorous, 95% 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.

3. EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for refrigerant piping installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

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

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 GENERAL

.1 Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5 and Section 23 05 05 - Installation of Pipework.

3.4 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.

3.5 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.

.2 Hot gas lines:

.1 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.

.2 Provide trap at base of risers greater than 2400 mm high and at each 7600 mm thereafter.

.3 Provide inverted deep trap at top of risers.

.4 Provide double risers for compressors having capacity modulation.

.1 Large riser: install traps as specified.

.2 Small riser: size for 5.1 m^3/s at minimum load. Connect upstream of traps on large riser.

3.6 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.

3.7 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 Consultant.

.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 Consultant.

.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 product[s] 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 three days of review, and submit, immediately, to Consultant.

3.8 DEMONSTRATION

.1 Instructions:

.1 Post instructions in frame with glass cover in accordance with Section 01 78 00 - Closeout Submittals and CSA B52.

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.

END OF SECTION

1.0 Approved: 2018-01-29

1.0 General

1.1 RELATED REQUIREMENTS

.1 Section 23 01 01.

1.2 REFERENCE STANDARDS

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

.2 ASTM International (ASTM)

.1 ASTM A240/A240M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.

.2 ASTM A635/A635M, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.

.3 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

.3 Green Seal Environmental Standards (GS)

.1 GS-36, Standard for Adhesives for Commercial Use.

.4 National Fire Protection Association (NFPA)

.1 NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.

.2 NFPA 90B, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.

.3 NFPA 91, Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particular Solids.

.4 NFPA 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

.5 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

.1 SMACNA HVAC Duct Construction Standards - Metal and Flexible.

.2 SMACNA HVAC Air Duct Leakage Test Manual.

.6 American Welding Society (AWS)

.1 AWS B2.2, Brazing Procedures and Performance Qualifications

.2 AWS D9.1, Sheet Metal Welding Code

1.3 SHOP DRAWING 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 metal ducts and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit specifically for the following:

.1 Plenum and plenum-related items showing physical dimensions, joints, sealants, door construction, and hardware.

.2 Factory fabricated ducts, fittings, and joining systems.

.2 Submit changes or alterations in ductwork layout with supporting calculations for pressure drop.

.4 Test and Evaluation Reports:

.1 Certification of Ratings:

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

.2 Construction IAQ Management Plan:

.1 Submit Indoor Air Quality (IAQ) Plan for construction and pre-occupancy phases of building as applicable.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:

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

.2 Store and protect ducts from nicks, scratches, blemishes, theft, vandalism and vermin.

.3 Replace defective or damaged materials with new.

.4 Handle and install ductwork in accordance with the advanced level described in SMACNA Duct Cleanliness for New Construction Guidelines.

.5 Seal ductwork either by blanking or capping duct ends, bagging small fittings, surface wrapping or shrink wrapping.

.6 Wipe internal surfaces of the uninsulated ductwork to remove excess dust immediately prior to installation.

.7 Seal open ends on completed ductwork and overnight work-in-progress.

.8 Firmly fit access covers position on completion of each section of the work.

.9 Keep protective coverings in place until immediately before installation.

.10 Close open ends of ductwork with temporary metal or polyethylene seals to prevent entry of dust and debris during construction.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

1.5 QUALITY ASSURANCE

.1 Perform Work to SMACNA - HVAC Duct Construction Standards - Metal and Flexible and ASHRAE standards.

.2 Perform Duct Leakage Testing to SMACNA "HVAC Air Duct Leakage Testing Manual"

.3 Brazing: Certify brazing procedures, brazers, and operators in accordance with AWS B2.2 Brazing Procedures and Performance Qualifications

.4 Welding: Certify welding procedures, welding equipment and welders in accordance with AWS D9.1 Sheet Metal Welding Code.

.5 No variation of duct configuration or sizes permitted except by written permission.

.6 Size round ducts installed in place of rectangular ducts to ASHRAE table of equivalent rectangular and round ducts.

.7 Sizes indicated on drawings are clear inside dimensions and do not include for duct linings.

2.0 Products

2.1 SEAL CLASSIFICATION

.1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	C
250	C
125	C
63	Unsealed

.2 Seal classification:

.1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.

.2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant.

.3 Class C: transverse joints and connections made airtight with gaskets and/or sealant. Longitudinal seams unsealed.

2.2 SEALANT

.1 Sustainability Characteristics:

.1 Adhesives and sealants: in accordance with Section 07 92 00 - Joint Sealants.

.2 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 or short radius with single thickness turning vanes, centreline radius: 1.5 times width of duct for standard, 1.0 times for short radius.

.2 Round: smooth radius or five piece, centreline radius: 1.5 times diameter.

.3 Mitred elbows, rectangular:

.1 To 400 mm width: with single thickness turning vanes.

.2 Over 400 mm: with double thickness turning vanes.

.4 Branches:

.1 Rectangular main and branch: with radius on branch 1.5 times width of duct.

.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 Full or short radiused elbows as indicated.

.7 Obstruction deflectors: maintain full cross-sectional area.

.1 Maximum included angles: as for transitions.

2.6 FIRE STOPPING

.1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 - Fire Stopping.

.2 Coordinate with 07 84 00 - Fire Stopping to ensure fire stopping materials and installation does not distort duct.

2.7 GALVANIZED STEEL

.1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.

.2 Thickness, fabrication and reinforcement: to ASHRAE and SMACNA.

.3 Joints: to ASHRAE and SMACNA. Provide proprietary manufactured duct joint where shown. Proprietary manufactured flanged duct joint to be considered to be a class A seal.

2.8 STAINLESS STEEL

.1 To ASTM A240/A240M, T304L or T316L.

.2 Finish: number 2B

.3 Thickness, fabrication and reinforcement: to ASHRAE and SMACNA or as indicated.

.4 Joints: to ASHRAE and SMACNA, continuous inert gas welded.

2.9 ALUMINUM

.1 To ASHRAE and SMACNA. Aluminum type: 3003-H-14.

.2 Thickness, fabrication and reinforcement: to ASHRAE and SMACNA.

.3 Joints: to ASHRAE and SMACNA. Provide continuous weld where indicated.

2.10 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: 500mm.

.2 Hanger configuration: to ASHRAE and SMACNA.

.3 Hangers: galvanized steel angle with galvanized steel rods to ASHRAE, SMACNA and following table:

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

.4 Provide stainless steel supports for stainless steel ductwork.

.5 Upper hanger attachments:

.1 For concrete: manufactured concrete inserts.

.2 For steel joist: manufactured joist clamp or steel plate washer to suit structure.

.3 For steel beams: manufactured beam clamps:

3.0 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 Consultant.

.2 Inform Consultant 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 Consultant.

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.

.3 Insulate strap hangers 100 mm beyond insulated duct.

.4 Support risers in accordance with ASHRAE and SMACNA.

.5 Install breakaway joints in ductwork on sides of fire separation.

.6 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.

.7 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

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 ASHRAE, SMACNA, and as follows:

Duct Size	**Spacing**
(mm)	(mm)
to 1500	3000
1501 and over	2500

3.4 WATERTIGHT DUCT

.1 Provide watertight duct for:

.1 Dishwasher exhaust.

.2 Plenums behind intake and exhaust louvres.

.3 Fresh air intake ductwork.

.4 Minimum 3000 mm from duct mounted humidifier in all directions.

.5 As indicated.

.2 Do not use spiral ducts or elbows for watertight exhaust systems.

.3 Form bottom of horizontal duct without longitudinal seams.

.1 Weld joints of bottom and side sheets.

.2 Seal other joints with duct sealer.

.4 Slope horizontal branch ductwork down towards fume hoods or equipment served.

.1 Slope header ducts down toward risers.

.5 Fit base of riser with 150 mm deep drain sump and 32 mm drain connected, with deep seal trap and valve and discharging to open funnel drain.

.6 Provide drains in fresh air intakes and exhaust plenums complete with trap and piped to 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 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.

END OF SECTION

1. GENERAL

1.1 GENERAL REQUIREMENTS

.1 Refer to Section 23 01 01.

1.1 REFERENCE STANDARDS

.1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

.1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

1.2 SHOP DRAWING 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 duct accessories and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Indicate:

.1 Flexible connections.

.2 Duct access doors.

.3 Turning vanes.

.4 Instrument test ports.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:

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

.2 Store and protect air duct accessories from nicks, scratches, and blemishes, vermin, theft and vandalism.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

2. PRODUCTS

2.1 GENERAL

.1 Manufacture in accordance with SMACNA - HVAC Duct Construction Standards.

2.2 FLEXIBLE CONNECTIONS

.1 Frame: galvanized sheet metal frame 2.3mm thick with fabric clenched by means of double locked seams.

.2 Material:

.1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, density of 1.3 kg/m^2.

2.3 ACCESS DOORS IN DUCTS

.1 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.

.2 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.

.3 Gaskets: neoprene

.4 Hardware:

.1 Up to 300 x 300 mm: two sash locks complete with safety chain.

.2 301 to 450 mm: four sash locks complete with safety chain.

.3 451 to 1000 mm: piano hinge and minimum two sash locks.

.4 Doors over 1000 mm: piano hinge and two handles operable from both sides.

.1 Hold open devices.

.2 300 x 300 mm glass viewing panels.

2.4 TURNING VANES

.1 Factory or shop fabricated single thickness or double thickness with trailing edge, to recommendations of SMACNA and as indicated.

2.5 INSTRUMENT TEST PORTS

.1 1.6 mm thick steel zinc plated after manufacture.

.2 Cam lock handles with neoprene expansion plug and handle chain.

.3 28 mm minimum inside diameter. Length to suit insulation thickness.

.4 Neoprene mounting gasket.

2.6 SPIN-IN COLLARS

.1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.

.2 Sheet metal thickness to co-responding round duct standards.

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 duct accessories installation in accordance with manufacturer's written instructions.

- .1 Visually inspect substrate in presence of Consultant.
- .2 Inform Consultant of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 INSTALLATION

.1 Flexible Connections:

- .1 Install in following locations:
  - .1 Inlets and outlets to supply air units and fans.
  - .2 Inlets and outlets of exhaust and return air fans.
  - .3 As indicated.
- .2 Length of connection: 100 mm.
- .3 Minimum distance between metal parts when system in operation: 75 mm.
- .4 Install in accordance with recommendations of SMACNA.
- .5 When fan is running:
  - .1 Ducting on sides of flexible connection to be in alignment.
  - .2 Ensure slack material in flexible connection.

.2 Access Doors and Viewing Panels:

- .1 Size:
  - .1 1200 x 1200 mm for person size entry.
  - .2 600 x 600 mm for servicing entry.
  - .3 300 x 300 mm for viewing.
  - .4 As indicated.
- .2 Locations:
  - .1 Fire and smoke dampers.
  - .2 Control dampers.
  - .3 Devices requiring maintenance.
  - .4 Required by code.
  - .5 Reheat coils.
  - .6 Elsewhere as indicated.

.3 Instrument Test Ports:

.1 General:

.1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.

.2 Locate to permit easy manipulation of instruments.

.3 Install insulation port extensions as required.

.4 Locations:

.1 For traverse readings:

.2 For temperature readings:

.4 Turning Vanes:

.1 Install in accordance with recommendations of SMACNA and 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.

.3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

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

END OF SECTION

1. GENERAL

1.1 GENERAL REQUIREMENTS

.1 Refer to Section 23 01 01.

1.1 REFERENCE STANDARDS

.1 Sheet Metal and Air Conditioning National Association (SMACNA)

.1 SMACNA HVAC Duct Construction Standards, Metal and Flexible.

1.2 SHOP DRAWING 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 dampers and include product characteristics, performance criteria, physical size, finish and limitations.

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 dampers for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:

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

.2 Store and protect dampers from nicks, scratches, blemishes, vermin, theft and vandalism.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

2. PRODUCTS

2.1 GENERAL

.1 Manufacture to SMACNA standards.

2.2 SPLITTER DAMPERS

.1 Fabricate from same material as duct but one sheet metal thickness heavier, with appropriate stiffening.

.2 Double thickness construction.

.3 Control rod with locking device and position indicator.

.4 Rod configuration to prevent end from entering duct.

.5 Pivot: piano hinge.

.6 Folded leading edge.

2.3 SINGLE BLADE DAMPERS

.1 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 100mm.

.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.

2.4 MULTI-BLADED DAMPERS

.1 Factory manufactured of material compatible with duct.

.2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.

.3 Maximum blade height: 100mm.

.4 Bearings: self-lubricating nylon.

.5 Linkage: shaft extension with locking quadrant.

.6 Channel frame of same material as adjacent duct, complete with angle stop.

.7 Maximum leakage: conform to ASHRAE 90.1 requirements.

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 Consultant.

.2 Inform Consultant 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 Consultant.

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.

.7 Corrections and adjustments conducted by Consultant.

3.3 CLEANING

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

.1 Leave Work area clean at end of each day.

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

.3 Waste Management: separate waste materials for recycling 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

1. GENERAL

1.1 GENERAL REQUIREMENTS

.1 Refer to Section 23 01 01.

1.1 REFERENCE STANDARDS

.1 ASTM International (ASTM)

.1 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.

1.2 SHOP DRAWING 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 dampers and include product characteristics, performance criteria, physical size, finish and limitations.

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 dampers for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:

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

.2 Store and protect dampers from nicks, scratches, blemishes, vermin, theft and vandalism.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

2. PRODUCTS

2.1 MULTI-LEAF DAMPERS

.1 Provide opposed or parallel blade type as indicated. Provide parallel blade type for backdraft and full open/full closed applications and opposed blade for modulating or adjustable applications.

.2 Extruded aluminum or structural steel, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, structurally formed and welded galvanized steel or extruded aluminum frame.

.3 Pressure fit self-lubricated nylon bearings.

.4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.

.5 Operator: to Division 25.

.6 Performance:

.1 Leakage: in closed position less than 4 cfm/sq. ft damper area at 1” w.c. differential across damper to AMCA 500.

.2 Pressure drop at full open position less than 0.08” w.c. differential across damper at 1000 fpm (24” x 24”).

.7 Insulated aluminum dampers:

.1 Frames: insulated with extruded polystyrene foam with RSI 0.88.

.2 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, RSI 0.88.

2.2 DISC TYPE DAMPERS

.1 Frame: insulated brake formed, welded, 1.6 mm thick, galvanized steel to ASTM A653/A653M.

.2 Disc: insulated spin formed, 1.6 mm thick, galvanized steel to ASTM A653/A653M.

.3 Gasket: extruded neoprene, field replaceable, with 10 year warranty.

.4 Bearings: roller self lubricated and sealed.

.5 Operator: compatible with damper, linear stroke operator, spring loaded actuator, zinc-aluminum foundry alloy casting cam follower.

.6 Performance:

.1 Leakage: in closed position less than 0.001% of rated air flow at 1” w.c. pressure differential across damper.

.2 Pressure drop: at full open position less than 0.1” w.c. differential across damper at 1000 fpm.

2.3 BACK DRAFT DAMPERS

.1 Automatic gravity operated, multi leaf, aluminum or steel construction with nylon bearings, centre pivoted, spring assisted or counterweighted.

2.4 RELIEF DAMPERS

.1 Automatic multi-leaf steel or aluminum dampers with ball bearing centre pivoted and counterweights set to open at 0.25” w.c. static pressure, or as indicated.

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 Consultant.

.2 Inform Consultant 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 Consultant.

3.2 INSTALLATION

.1 Install where indicated.

.2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.

.3 Seal multiple damper modules with silicon sealant.

.4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.

.5 Ensure dampers 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.

.3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal .

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

END OF SECTION

1. GENERAL

1.1 GENERAL REQUIREMENTS

.1 Refer to Section 23 01 01.

1.1 REFERENCE STANDARDS

.1 American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE)

.1 ASHRAE 70 - Method of Testing the Performance of Air Outlets and Air Inlets

.2 American Society of Testing and Materials (ASTM)

.1 ASTM 610 – Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces

.2 ASTM 714 – Test Method for Evaluating Degree of Blistering of Paints

.3 ASTM D1308 – Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes

.4 ASTM D1654 – Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

.5 ASTM D4752 – Standard Practice for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub

.3 National Fire Protection Association (NFPA)

.1 NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems

.4 Underwriters Laboratories (UL/ULC)

.1 UL/ULC – Underwriters Laboratories Fire Resistance Directory/Underwriters Laboratories of Canada Equipment and Materials Directory, if applicable.

1.2 SHOP DRAWING 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 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 Air pressure drop, static and dynamic.

.5 Neck velocity.

1.3 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.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:

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

.2 Store and protect diffuser, registers and grilles from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

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

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 GENERAL

.1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity as indicated.

.2 Frames:

.1 Full perimeter gaskets.

.2 Plaster frames where set into plaster or gypsum board and as specified.

.3 Concealed fasteners.

.3 Concealed manual volume control damper operators.

.4 Colour: standard or as shown.

2.3 MANUFACTURED UNITS

.1 Grilles, registers and diffusers of same generic type, products of one manufacturer.

2.4 PAINTING

.1 Provide baked-on powder coat finish.

.1 The paint finish must demonstrate no degradation when tested in accordance with ASTM D1308 (covered and spot immersion) and ASTM D4752 (MEK double rub) paint durability tests.

.2 Paint film thickness: minimum of 2.0 mils.

.3 The finish hardness: 2H.

.4 Minimum salt spray exposure of 500 hours with no measurable creep in accordance with ASTM D1654, and 1000 hours of exposure with no rusting or blistering as per ASTM D610 and ASTM D714.

.5 Finish impact resistance: 80 inch-pounds.

.2 Provide components with a custom finish in a color to match a customer supplied sample where indicated.

2.5 SUPPLY GRILLES AND REGISTERS

.1 Aluminum Louvred Grilles

.1 Aluminum, 32 mm border, adjustable double deflection with airfoil shape, face bares parallel to long dimension and rear bars parallel to short dimension. Finish standard or as shown. Model as shown.

.2 General: with opposed blade dampers.

.2 Slot Diffusers

.1 1 to 10 discharge slots with 12mm, 19mm, 25mm or 38mm slot width.

.2 Aerodynamically curved “ice-tong” shaped pattern controllers for 180 degree air pattern control and airflow dampering, if required.

.3 Return units match the supply units in appearance.

.4 Diffuser border extruded aluminum construction with extruded aluminum spacers and mitered end flanges.

.5 Continuous length units shall be provided with factory assembled corner modules to suit drawings and site conditions. Splice plates and alignment plates shall be provided to align continuous slot assemblies. The maximum section length shall be 1800mm.

.6 Linear slot diffusers shall be compatible for surface mounting or T-bar lay in mounting as applicable with the following border style as per Architect.

.7 Provide slot diffusers and grilles with manufacturer's straight shoulder diffuser plenum

.1 Constructed of zinc coated steel.

.2 Assembly shall have a side inlet configuration in sizes to fit Model SD slot diffusers with one to four slots.

.3 Available to suit both drywall and lay-in applications.

.4 Internally lined with 1/4 inch thick fiberglass insulation.

2.6 RETURN AND EXHAUST GRILLES AND REGISTERS

.1 Aluminum Louvred Grilles

.1 Aluminum, 32 mm border, adjustable double deflection with airfoil shape, face bares parallel to long dimension and rear bars parallel to short dimension. Finish standard or as shown. Model as shown.

.2 General: with opposed blade dampers.

.2 Slot Return Grilles

.1 Refer to Supply Grilles and Registers specification above.

.3 Egg Crate Return/Exhaust Grilles

.1 Aluminum, 32 mm border, 12 x 12 mm egg crate type face bars. Finish standard or as shown. Model as shown.

2.7 LINEAR GRILLES

.1 Bar core type with margin as indicated.

.2 Plaster frame, sealing strip and accessories as indicated. Finish standard or as shown. Model as shown.

.3 Air volume control damper with concealed adjustment.

.4 Floor and sill grilles to be capable of supporting 90 kg point load weight between supports with negligible deflection and be heel proof.

.5 Linear Floor Grilles

.1 Construction

.1 Grille face and border suitable for a drop-in installation.

.2 Grilles shall have fixed 0 degree, 15 degree, or 30 degree blades spaced 6mm, 11mm, or 12mm on center, with the blades running parallel to the long dimension of the grille.

.3 The outlet core shall have extruded aluminum receiving bar.

.4 The grille border shall be heavy-duty extruded aluminum construction with precise factory mitered corners and reinforcing support bars for extra support for the core receiving bar.

.5 The support and receiving bars shall not exceed 152mm on center.

.2 Mounting/Fastening

.1 Core held into the border with removable core clips, allowing the removal of the core without special tools.

.2 The frame attached to the floor with countersunk screws.

2.8 SIGHT-PROOF OR LIGHT PROOF TRANSFER/DOOR GRILLES – ALUMINUM

.1 Construction: aluminum core and frame material

.2 Finish: baked-on powder coat.

.3 Border:

.1 Channel border for on-site wood trim framing by others.

.2 Flat border, one side:

.1 32mm wide flat border on one side.

.2 Include countersunk screw hole fastening.

.3 Flat border, both sides:

.1 32mm wide flat border on both sides.

.2 Include countersunk screw hole fastening.

.4 Finish: standard or as shown.

.5 Model: as shown.

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 Consultant.

.2 Inform Consultant 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 Consultant.

3.2 INSTALLATION

.1 Install in accordance with manufacturers instructions.

.2 Install with flat head stainless steel 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.

.3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal .

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

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 23 01 01.

.2 Section 23 31 13.01

1.2 REFERENCE STANDARDS

.1 American National Standard Institute (ANSI)/American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

.1 ANSI/ASHRAE 52.2-12, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particulate Size (ANSI approved).

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-115.10-M90, Disposable Air Filters for the Removal of Particulate Matter from Ventilating Systems.

.2 CAN/CGSB-115.11-M85, Filters, Air, High Efficiency, Disposable, Bag Type.

.3 CAN/CGSB-115.12-M85, Filters, Air, Medium Efficiency, Disposable, Bag Type.

.4 CAN/CGSB-115.13-85, Filter Media, Automatic Roll.

.5 CAN/CGSB-115.14-M91, High Efficiency Cartridge Type Supported Air Filters for the Removal of Particulate Matter from Ventilating Systems.

.6 CAN/CGSB-115.15-M91, High Efficiency Rigid Type Air Filters for Removal of Particulate Matter from Ventilating Systems.

.7 CAN/CGSB-115.16-M82, Activated Carbon for Odor Removal from Ventilating Systems.

.8 CAN/CGSB-115.18-M85, Filter, Air, Extended Area Panel Type, Medium Efficiency.

.9 CAN/CGSB-115.20-95, Polarized Media Air Filter.

.3 International Organization of Standardization (ISO)

.1 ISO 14644-1-99, Clean Rooms and Associated Controlled Environments - Part 1: Classification of Air Cleanliness.

.4 National Fire Protection Association (NFPA)

.1 NFPA 96-11, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

.5 Underwriters' Laboratories of Canada (ULC)

.1 ULC -S111-07, Standard Method of Fire Tests for Air Filter Units.

.2 ULC-S646-06, Exhaust Hoods and Related Controls for Commercial and Institutional Kitchens.

.6 US Department of Defense - Test Method Standard

.1 MIL-STS-282-95, Filter Units, Protective Clothing, Gas-Mask Components and Related Products; Performance Test Methods.

1.3 SHOP DRAWING 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 HVAC filters and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.4 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials:

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

.2 Furnish list of individual manufacturer's recommended spare parts for equipment such as frames and filters, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing for inclusion in operating manual.

.3 Spare filters: in addition to filters installed immediately prior to acceptance by Consultant, supply one complete set of filters for each.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:

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

.2 Store and protect HVAC filters from nicks, scratches, blemishes, vermin, vandalism, and theft.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse of 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 GENERAL

.1 Media: suitable for air at 100% RH and air temperatures between -40 and 50 °C.

.2 Number of units, size and thickness of panels, overall dimensions of filter bank, configuration and capacities: as indicated.

.3 Pressure drop when clean and dirty, sizes and thickness: as indicated on schedule.

2.2 ACCESSORIES

.1 Holding frames: permanent "T" section or channel section construction of galvanized steel or extruded aluminum, 1.6 mm thick, except where specified.

.2 Seals: to ensure leakproof operation.

.3 Blank-off plates: as required, to fit all openings and of same material as holding frames.

.4 Access and servicing: through doors/panels on each side and/or from upstream face of filter bank.

2.3 FIBROUS GLASS PANEL FILTERS

.1 Disposable fibrous glass media: to CAN/CGSB-115.10 with adhesive.

.2 Holding frame: 1.2 mm minimum thick galvanized steel with 3 mm diameter hinged wire mesh screen.

.3 Performance: minimum average synthetic dust weight arrestance 70% to ANSI/ASHRAE 52.2.

.4 Fire rated: to ULC -S111.

2.4 CARTRIDGE TYPE FILTERS, 80-85% EFFICIENCY

.1 Media: deep pleated, disposable, high efficiency, to CAN/CGSB-115.14.

.2 Holding frame: galvanized steel with bracing.

.3 Media support: welded wire grid.

.4 Performance: average atmospheric dust spot efficiency 80-85% to ANSI/ASHRAE 52.2.

.5 Fire rated: to ULC -S111.

2.5 CARTRIDGE TYPE FILTERS 95% EFFICIENCY

.1 Media: disposable, high efficiency, to CAN/CGSB-115.15.

.2 Holding frame: galvanized steel with bracing.

.3 Media support: welded wire grid.

.4 Performance: average atmospheric dust spot efficiency 95% to ANSI/ASHRAE 52.2.

.5 Fire rated: to ULC-S111.

2.6 FILTER GAUGES - DIAL TYPE

.1 Diaphragm actuated, direct reading.

.2 Range: 0 to 2 times initial pressure.

2.7 FILTER GAUGES - MANOMETER TYPE

.1 Inclined acrylic tube.

.2 Complete with levelling screws.

.3 Range: 0 to 2 times initial pressure.

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 filter installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

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

3.2 INSTALLATION GENERAL

.1 Install in accordance with manufacturer's recommendations and with adequate space for access, maintenance and replacement.

3.3 REPLACEMENT MEDIA

.1 Replace media with new upon acceptance.

.2 Filter media new and clean, as indicated by pressure gauge, at time of acceptance.

.3 installation.

3.4 FILTER GAUGES

.1 Install type as indicated across each filter bank (pre-filter and final filter) in approved and easy readable location.

.2 Mark each filter gauge with value of pressure drop for clean condition and manufacturer's recommended replacement (dirty) value.

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.

.3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

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

END OF SECTION

1. GENERAL

1.1 GENERAL REQUIREMENTS

.1 Refer to Section 23 01 01.

1.1 REFERENCE STANDARDS

.1 CSA Group (CSA)

.1 CSA C22.2 No.155, Electric Duct Heaters

1.2 SHOP DRAWING 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 duct heaters and controls and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit drawings showing:

.1 Element support details.

.2 Unit support.

.3 Internal components wiring diagrams.

.2 Submit duct heater schedule indicating quantities, sizes, mounting arrangement and the following performance data:

.1 Electrical: total kW rating, voltage, phase.

.2 Heater element watt/density.

.3 Controller type.

.4 Number of stages and kW rating.

.5 Minimum operating airflow.

.6 Maximum discharge temperature.

.7 Pressure drop at operating and minimum airflow.

.8 Accessories included.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 23 05 00 - Common Work Results for HVAC and manufacturer's written instructions.

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

2. PRODUCTS

2.1 OPEN COIL DUCT HEATERS

.1 Duct heater approved to CSA C22.2 No.155 and listed for zero clearance to combustible material.

.2 Design/Performance Criteria:

.1 Refer to duct heater schedule for size, electrical requirements (volts, phases), capacity (kW), operating airflow, controller type, number of stages and special accessories.

.2 Heater Element Watt/Density: maximum 242 W/mm^2.

.1 Provide derated coils with low-watt density and low airflow controls when faced velocities are lower than 2.0 m/s or duct heaters are used in variable-air-volume applications.

.3 Heater Rated Load: provide built-in load fuses for duct heaters with rated load exceeding 48 Amps.

.4 Modular Construction: when duct heater modules are assembled on site for large applications, design and construct assembly to operate as a single heater.

.5 Disconnect Switch: provide main disconnect for each duct heater assembly.

.3 Construction:

.1 Frame: corrosion-resistant galvanized steel.

.2 Heating elements: helical coils of high grade nickel-chrome alloy resistance wire supported and insulated by floating ceramic bushings fastened to the frame and supporting brackets.

.3 Coil terminal pins: mechanically secured and insulated from the frame with high temperature ceramic bushings.

.4 Mounting: slip-in insertion type or flanged type as indicated on duct heater schedule.

.5 Protective Screens: installed on both sides of heater.

.4 Safety Controls:

.1 High Temperature Cutouts: include fail-safe thermal protection devices which automatically de-energize the heater on overheating condition.

.1 Primary High Limit Switch: automatic reset disc type thermal cutout.

.2 Secondary High-Limit Switch: additional manual reset disc type thermal cutout for duct heaters of 30 kW and less.

.2 Airflow Proving Switch: diaphragm type air pressure switch with automatic reset, screw type setpoint adjustment and static pressure probe; switch to de-energize duct heater circuits in case of insufficient air flow.

.5 Panel:

.1 Factory mounted NEMA 1 enclosure with terminal blocks for single point power connections and connection of wiring to thermostat, airflow proving switch and/or external controls.

.2 Remote mounted NEMA 1 panel as indicated with terminal strips in heater terminal box for power and control wiring.

.3 All built-in controls and electrical components to be factory mounted and wired inside the panel; wiring to be terminated on clearly identified terminal blocks.

.4 Provide unit specific wiring diagram permanently attached inside the panel.

.6 Controls:

.1 Duct heater to include the following built-in controls: magnetic contactors, control transformer, safety controls and controllers.

.2 Controller Type: as indicated on duct heater schedule.

.1 Stage Control: on-off control of a single or multiple stages.

.2 Proportional Control: single-stage proportional control providing full modulation of the heater's capacity.

.3 Hybrid Control: Vernier type step control system combining multiple on-off stages with one proportional SCR stage.

2.2 ACCESSORIES

.1 Provide accessories where indicated on duct heater schedule.

.2 Pilot Lights: factory mounted and wired on heater panel showing staging, power supply status, overheating condition, no airflow, heating status.

.3 Thermostats: low voltage electronic thermostat compatible with duct heater controller.

.1 Room Thermostats: ventilated casing with adjustable setpoint.

.2 Duct Thermostats: insertion type with casing and adjustable setpoint.

3. EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions: verify site conditions are acceptable for duct heater installation in accordance with manufacturer's written instructions.

.1 Inform Consultant of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 INSTALLATION

.1 Perform installation in accordance with manufacturer's instructions.

.2 Locate duct heater in accordance with manufacturer's minimum recommended distances for operation, service access and unit removal.

.3 Provide additional hangers and supports in accordance with Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment where duct heater weight cannot be supported solely by existing duct.

.4 Make power and control connections to CSA C22.2 No.155.

.5 Verify that ductwork and casings are free of debris before operating and testing duct heaters.

3.3 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 01 91 13 - General Commissioning Requirements and Section 26 05 00 - Common Work Results for Electrical.

.2 Duct Heater Controls: test operation of safety controls and duct heater staging/modulation by simulating a demand from the local thermostat or external control signal.

.3 Field Adjustments: test and adjust airflow controls during system testing, adjusting and balancing in coordination with Section 23 05 93 – Testing, Adjusting and Balancing for HVAC.

.4 Perform tests in presence of Consultant.

.5 Provide test report and include copy with Operations and Maintenance Manuals.

3.4 CLEANING

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

.1 Leave Work area clean at end of each working 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.

END OF SECTION

1. GENERAL

1.1 GENERAL REQUIREMENTS

.1 Refer to Section 23 01 01.

1.2 REFERENCE STANDARDS

.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)

.1 ASHRAE 84, Method of Testing Air-to-Air Heat/Energy Exchangers (ANSI approved).

1.3 SHOP DRAWING 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 energy recovery equipment and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.4 Test Reports:

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

.2 Provide confirmation of testing.

.5 Manufacturers' Instructions: submit manufacturer's installation instructions.

1.4 MAINTENANCE MATERIAL SUBMITTALS

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

.2 Extra Materials:

.1 Furnish list of individual manufacturer's recommended spare parts for equipment include:

.1 Bearings and seals.

.2 Addresses of suppliers.

.2 List of specialized tools necessary for adjusting, repairing or replacing.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:

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

.2 Store and protect energy recovery equipment from nicks, scratches, blemishes, vermin vandalism or theft.

.3 Replace defective or damaged materials with new.

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

2. PRODUCTS

2.1 GENERAL

.1 Comply with ASHRAE 84.

2.2 AIR-TO-AIR ENERGY RECOVERY VENTILATOR (ERV)

.1 Factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, control circuit board and blowers with motors, filters, and insulated foam air guides. Each unit will have an automatic by-pass damper system for economic operation under certain conditions. The unit shall have factory installed control board with functions for local, remote, and optional control modes.

.2 Unit Cabinet:

.1 The cabinet shall be fabricated of galvanized steel, and covered with polyurethane foam insulation as necessary with steel mounting points securely attached

.3 Blowers:

.1 Furnished with two (2) direct drive centrifugal blowers running simultaneously supplying and extracting air at the same rate for balanced ventilation air flow.

.2 Blower motors directly connected to the blower wheels and have permanently lubricated bearings.

.3 The blowers and motors mounted for quiet operation.

.4 Heat Exchanger

.1 Heat exchanger element shall be constructed of specially treated cellulous fiber membrane separated by corrugated layers to allow total heat (sensible and latent) energy recovery from the exhaust air to the supply air or from the supply air to the exhaust air as determined by design conditions.

.2 Element have protective filters installed at both the supply and exhaust sides with an access cover to allow easy maintenance.

.5 Bypass Damper

.1 The ERV shall have an automatic supply side by-pass damper to allow inbound ventilation air to by-pass the energy transfer core when outside weather conditions warrant.

.2 Mechanism for opening and closing the bypass damper shall be a 208V-230V synchronous electric motor through an actuator. The motor will drive a steel cable connected to an mechanical damper flap to allow fresh air to bypass the element.

.3 Supply and return air thermistor shall control the damper and may be interlocked with a LCD remote controller.

.6 Filter

.1 The ERV shall be equipped with factory installed air filters located at each intake face (both supply and exhaust sides) of the® core to clean the air and prevent clogging.

.7 Mounting

.1 Mounting of the ERV shall be as indicated in the plans and drawings. The ERV shall not require and condensate pan or receptacle nor condensate drain or piping. Mounting may be horizontal or vertical and the unit may be inverted as required by ductwork connection.

.8 Control

.1 A 30vdc fuzzy logic signal via a 2 conductor non polar shielded, jacketed control wire to LCD remote controller or interlocked with indoor unit.

.2 ERV Control board shall allow independent control by contact closure from third-party sensor-driven controllers, switches, or timers.

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 Consultant.

.2 Inform Consultant 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 Consultant.

3.2 INSTALLATION

.1 Install in accordance with manufacturers recommendations.

.2 Support independently of adjacent ductwork with flexible connections.

.3 Install access doors in accordance with Section 23 33 00 - Air Duct Accessories for access to coils, dampers, etc.

3.3 FIELD QUALITY CONTROL

.1 Tests:

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

3.4 AIR-TO-AIR ENERGY RECOVERY VENTILATOR (ERV)

.1 Ductwork:

.1 Supply, install, test and commission all interconnecting ductwork for the ERV units.

.2 Ensure ductwork sizing, layout, fittings, etc. are in strict accordance with the design requirements.

.3 Provide the two outdoor ducts with heat insulating material to prevent condensation from forming.

.4 Tilt the two outdoor-connected ducts at a gradient (1/30 or more) down toward the outdoor area from unit.

.2 Preheater (For Winter Design Temperature Less than -10°C):

.1 Provide pre-heater to pre-heat and maintain the air entering the ERV to above -10°C.

.2 Size to increase the temperature of the incoming supply air based on the heating (winter) design condition of the applicable site.

.3 Where the outside air is mixed into the return air of an indoor unit size pre-heater so that the mixed air temperature of return and ventilation air is always greater than 13°C.

.4 Install according to the manufacturer’s recommendation

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.

.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.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 01 01.

1.2 REFERENCE STANDARDS

.1 CSA Group (CSA)

.1 CAN/CSA - B52 Mechanical Refrigeration Code.

.2 American Society for Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)

.1 ASHRAE 90.1 - Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings

.3 Air-Conditioning, Heating and Refrigeration Institute (AHRI)

.1 AHRI 1230 - Performance Rating of Variable Refrigerant Flow (VRF) MultiSplit Air-Conditioning and Heat Pump Equipment

1.3 SHOP DRAWING 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 energy recovery equipment and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.4 Test Reports:

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

.2 Provide confirmation of testing.

.5 Manufacturers' Instructions: submit manufacturer's installation instructions.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:

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

.2 Store and protect products from nicks, scratches, blemishes, vermin vandalism or theft.

.3 Replace defective or damaged materials with new.

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

1.5 WARRANTY

.1 The Heat Recovery units shall be covered by the manufacturer's limited warranty for a period of one (1) year parts and seven (7) year compressor to the original owner from date of installation.

.2 Manufacturer shall have a minimum of fifteen (15) years continuous experience providing VRF systems in the Canadian market.

.3 Manufacturer technical and service manuals must be readily available for download by any local contractor should emergency service be required.

2 PRODUCTS

2.1 SIMULTANEOUS HEATING/COOLING (HEAT RECOVERY), WATER-COOLED UNITS

.1 General

.1 Provide water-source unit, Branch Circuit (BC) Controller, indoor units, and M-NET DDC (Direct Digital Controls). Provide water-sourced units equipped with multiple circuit boards that interface to the M-NET controls system to perform functions necessary for operation. Provide factory assembled, piped and wired. Each unit shall be run tested at the factory.

.2 The water source units shall have a sound rating no higher than 58 dB(A) individually or 60 dB(A) twinned. If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.

.3 All refrigerant lines from the water-source unit to the BC (Branch Circuit) Controller(s) and from the BC Controllers to the indoor unit(s) shall be individually insulated in accordance with the installation manual.

.4 The water-source unit shall have an accumulator with refrigerant level sensors and controls.

.5 The water-source unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.

.6 The water-source unit shall have a high pressure safety switch, low pressure safety switch and over-current protection and DC bus protection.

.7 The water-source unit shall have a freeze protection sensor to shut the unit off in the event of water flow failure.

.8 The unit shall have integral proof of flow contacts wired to field-provided flow switch to protect the heat exchanger upon normal operating conditions.

.9 The water-source unit shall have the ability to operate with a maximum height difference of 164 feet and have total refrigerant tubing length of 1,804 – 2,461 feet depending on the unit distance from the BC controller. The greatest length is not to exceed 541 feet between water-source unit and the indoor units.

.10 The water-source unit shall be capable of continuous operation in heating or cooling mode with entering supply water temperature range between 23°F and 113°F without bypass valving.

.11 The water-source units are intended for installation indoors with an ambient temperature between 32°F DB and 104°F DB.

.12 The water source unit shall be installed with strainer in water line near water inlet to protect heat exchanger from debris in water lines.

.13 The water-source unit shall have 0-10V output signal or two position valve closure interlock available.

.14 The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained. Oil return sequences must be enabled only during extended periods of reduced refrigerant flow to ensure no disruption to correct refrigerant flow to individual zones during peak loads. Systems which might engage oil return sequence based on hours of operation risk oil return during inopportune periods are not allowed. Systems which rely on sensors (which may fail) to engage oil return sequence are not allowed.

.15 The unit shall have the capability of 4 levels of demand control for each refrigerant system based on external input.

.16 The unit shall have the capability of interlocking operation of the water circuit and error detection.

.2 Unit Cabinet

.1 The cabinet(s) shall be fabricated of hot-dip galvanized steel sheet for corrosion resistance.

.2 The water-source units can be mounted side-by-side or stacked (with proper structural supports) depending on selected connection locations.

.3 Inverter Cooler

.1 The water-source unit shall have an internal direct expansion type inverter cooler. The inverter cooler shall provide cooling for all internal cabinet components eliminating the need for cabinet ventilation.

.2 Alternate systems without integral cooling for internal cabinet components shall require additional indoor unit(s) size for total heat rejection by water-source unit plus additional capacity to account for load.

.4 Refrigerant

.1 Polyolester (POE) oil shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (SDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.

.2 Refrigerant piping shall be phosphorus deoxidized copper (copper and copper alloy seamless pipes) of sufficient radial thickness as defined by the VRF equipment manufacturer and installed in accordance with manufacturer recommendations.

.3 All refrigerant piping must be insulated with ½" closed cell, CFC-free foam insulation with flame-Spread Index of less than 25 and a smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102. R value of insulation must be at least 3.

.4 Refrigerant line sizing shall be in accordance with manufacturer specifications

.5 Heat Exchanger Coil

.1 The water-source heat exchanger shall be a cross-flow, stainless steel brazed plate heat exchanger. The channel plate shall be constructed from AISI 316 SS. The Frame/Pressure plate shall be constructed from AISI 304 SS. The brazing material shall be pure copper.

.2 The channel plate shall be constructed from AISI 316 SS. The Frame/Pressure plate shall be constructed from AISI 304 SS. The brazing material shall be pure copper.

.3 The heat exchanger shall be rated for a maximum of 2 MPa.

.4 The water-source unit shall be used in a closed water loop system.

.6 Compressor

.1 All water source units shall be equipped with one inverter driven scroll hermetic compressor.

.2 A crankcase heater shall be factory mounted on the compressor.

.3 The water-source unit compressor shall have an inverter to modulate capacity.

.4 The water-source unit compressor shall have an inverter to modulate capacity. The compressor operating range shall be capable of variable down to 14% to 100%, depending upon unit capacity, operating condition, and configuration.

.5 The compressor shall be equipped with an internal thermal overload.

.6 The compressor shall be mounted to avoid the transmission of vibration.

.7 Field-installed oil equalization lines between modules are not allowed.

.7 Electrical

.1 The outdoor unit shall be controlled by integral microprocessors.

.2 The control circuit between the indoor units, BC Controller and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

2.2 BRANCH CIRCUIT (BC) CONTROLLERS

.1 General:

.1 BC (Branch Circuit) Controllers (or comparable branch devices) shall include multiple branches to allow simultaneous heating and cooling by allowing either hot gas refrigerant to flow to indoor unit(s) for heating or subcooled liquid refrigerant to flow to indoor unit(s) for cooling. Refrigerant used for cooling must always be subcooled for optimal indoor unit LEV performance; alternate branch devices which do not include controlled refrigerant subcooling risk bubbles in liquid supplied to indoor unit LEVs and are not allowed.

.2 BC Controllers (or comparable branch devices) shall be equipped with a circuit board that interfaces to the controls system and shall perform all functions necessary for operation. The unit shall have a galvanized steel finish and be completely factory assembled, piped and wired. Each unit shall be run tested at the factory. This unit shall be mounted indoors, with access and service clearance provided for each controller. BC Controllers (or comparable branch devices) shall be suitable for use in plenums in accordance with UL1995 ed 4.

.2 Unit cabinet:

.1 The casing shall be fabricated of galvanized steel.

.2 Each cabinet shall house a liquid-gas separator and multiple refrigeration control valves.

.3 The unit shall house two tube-in-tube heat exchangers.

.3 Refrigerant Piping:

.1 All refrigerant pipe connections shall be brazed.

.2 Future changes to indoor unit quantities or sizes served by BC Controller or comparable branch device must be possible with no piping changes except between the branch device and indoor unit(s) changing. Systems which might require future piping changes between branch device and outdoor unit—if changes to indoor unit quantities or sizes are made—are not considered equal and are not allowed.

.4 Refrigerant Valves:

.1 Service shut-off valves shall be field-provided/installed for each branch to allow service to any indoor unit without field interruption to overall system operation.

.5 Condensate Management:

.1 BC Controller (or comparable branch device) must have integral resin drain pan or insulate refrigeration components with removable insulation that allows easy access for future service needs. Cabinets filled with solid foam insulation do not allow for future service and are not allowed.

.6 Electrical:

.1 As shown.

.2 The BC Controller shall be controlled by integral microprocessors

.3 The control circuit between the indoor units and outdoor units shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total.

2.3 INDOOR UNIT

.1 General:

.1 The ceiling-concealed ducted indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory. The unit shall be suitable for use in plenums in accordance with UL1995 ed 4.

.2 Unit Cabinet:

.1 The unit shall be ceiling-concealed, ducted—with a 2-position, field adjustable return and a fixed horizontal discharge supply.

.2 The cabinet panel shall have provisions for a field installed filtered outside air intake.

.3 Fan:

.1 Indoor unit shall feature multiple external static pressure settings ranging from 0.14 to 0.60 in. WG.

.2 The indoor unit fan shall be an assembly with statically and dynamically balanced Sirocco fan(s) direct driven by a single motor with permanently lubricated bearings.

.3 The indoor fan shall consist of three (3) speeds, High, Mid, and Low plus the Auto-Fan function

.4 Filter:

.1 Remove factory supplied washable filter after installation

.2 Install Optional return air mixing box with remote Merv 13 RA filter & grille

.5 Coil:

.1 The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy.

.2 The coils shall be pressure tested at the factory.

.3 Coil shall be provided with a sloped drain pan. Units without sloped drain pans which must be installed cockeyed to ensure proper drainage are not allowed.

.4 The unit shall be provided with an integral condensate lift mechanism able to raise drain water 27 inches above the condensate pan.

.6 Electrical:

.1 The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.

.2 The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

.7 Controls:

.1 Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.

.2 Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.

.3 Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.

.4 Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

2.4 CONTROLS:

.1 Overview:

.1 The control system shall consist of a low voltage communication network and a web-based interface. The controls system shall gather data and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface.

.2 Furnish energy conservation features such as optimal start, request-based logic, and demand level adjustment of overall system capacity as specified in the sequence.

.3 System shall be capable of email generation for remote alarm annunciation.

.2 Electrical Characteristics:

.1 General:

.1 Controller power and communications shall be via a common non-polar communications bus and shall operate at 30VDC.

.2 Wiring:

.1 Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit, to the BC controller (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.

.2 Control wiring for centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to the system controllers (centralized controllers and/or integrated web based interface), to the power supply.

.3 Wiring type:

.1 Wiring shall be 2-conductor (16 AWG), twisted, stranded, shielded wire as defined by the Diamond System Builder output.

.2 Network wiring shall be CAT-5 with RJ-45 connection.

.3 The CMCN shall operate at 30VDC. Controller power and communications shall be via a common non-polar communications bus.

.4 Wiring:

.1 Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit, to the BC controller (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.

.2 Control wiring for the Smart ME remote controller shall be from the remote controller to the first associated indoor unit (TB-5) M-NET connection. The Smart ME remote controller shall be assigned an M-NET address.

.3 Control wiring for the Simple MA and Wireless MA remote controllers shall be from the remote controller (receiver) to the first associated indoor unit (TB-15) then to the remaining associated indoor units (TB-15) in a daisy chain configuration.

.4 Control wiring for centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to the system controllers (centralized controllers and/or integrated web based interface), to the power supply.

.5 The AE-200, AE-50, and EB-50GU centralized controller shall be capable of being networked with other AE-200, AE-50, and EB-50GU centralized controllers for centralized control.

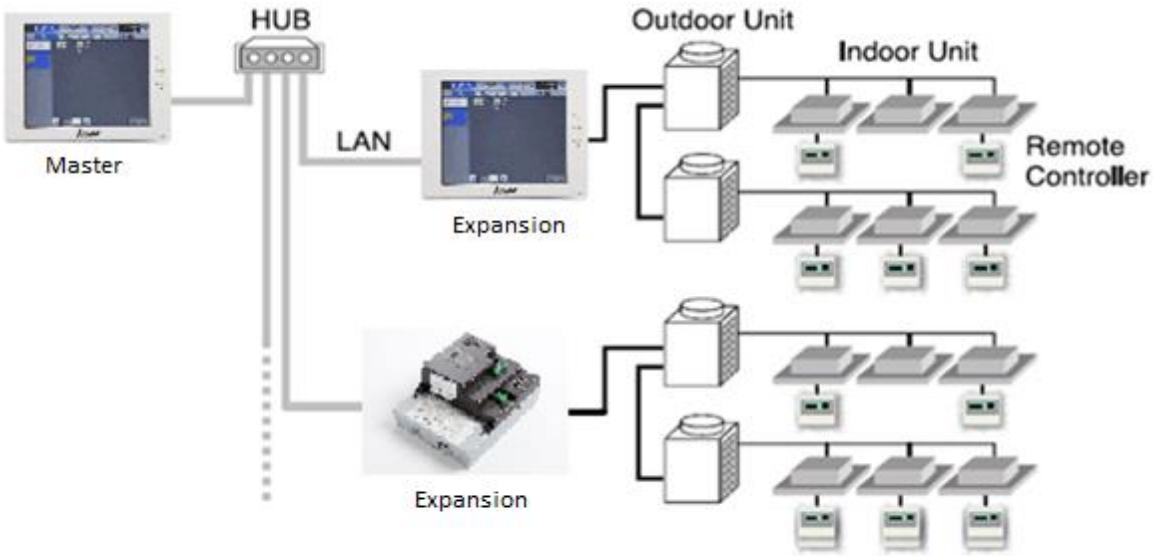
.5 Wiring type:

.1 Wiring shall be 2-conductor (16 AWG), twisted, stranded, shielded wire as defined by the Diamond System Builder output.

.2 Network wiring shall be CAT-5 with RJ-45 connection.

.6 Controls Network

.1 The Controls Network (CMCN) consists of remote controllers, centralized controllers, and/or integrated web based interface communicating over a high-speed communication bus. The Toshiba Controls Network shall support operation monitoring, scheduling, occupancy, error email distribution, personal web browsers, tenant billing, online maintenance support, and integration with Building Management Systems (BMS) using either LonWorks® or BACnet® interfaces. The below figure illustrates a sample CMCN System Configuration.



CMCN System Configuration

.7 CMCN System integration:

.1 The CMCN shall be capable of supporting integration with Building Management Systems (BMS) via industry standard communication protocols including BACnet and LonWorks®.

.8 CMCN Remote Controllers

.1 The Backlit Simple MA Remote Controller shall be capable of controlling up to 16 indoor units (defined as 1 group).

.2 The Backlit Simple MA Remote Controller shall only be used in same group with Wireless MA Remote Controllers or with other Backlit Simple MA Remote Controllers, with up to two remote controllers per group.

Simple MA Remote Controller			
Item	**Description**	**Operation**	**Display**
ON/OFF	Run and stop operation for a single group	Each Group	Each Group
Operation Mode	Switches between Cool/Drying/Auto/Fan/Heat/Setback. Operation modes vary depending on the air conditioner unit. Auto and Setback mode are available for the R2/WR2-Series only.	Each Group	Each Group
Temperature Setting	Sets the temperature from 40°F – 95°F depending on operation mode and indoor unit. Separate COOL and HEAT mode set points available depending on central controller and connected mechanical equipment.	Each Group	Each Group
Fan Speed Setting	Available fan speed settings depending on indoor unit.	Each Group	Each Group
Air Flow Direction	Air flow direction settings vary depending on the indoor	Each Group	Each Group

Simple MA Remote Controller			
Item	**Description**	**Operation**	**Display**
Setting	unit model.		
Permit / Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter). *1: Centrally Controlled is displayed on the remote controller for prohibited functions.	N/A	Each Group *1
Display Indoor Unit Intake Temp	Measures and displays the intake temperature of the indoor unit when the indoor unit is operating.	N/A	Each Group
Display Backlight	Pressing the button lights up a backlight. The light automatically turns off after a certain period of time. (The brightness settings can be selected from Bright, Dark, and Light off.)	N/A	Each Unit
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed	N/A	Each Unit
Test Run	Operates air conditioner units in test run mode. *2 The display for test run mode will be the same as for normal start/stop (does not display “test run”).	Each Group	Each Group *2
Ventilation Equipment	Up to 16 indoor units can be connected to an interlocked system that has one ERV unit.	Each Group	N/A

Simple MA Remote Controller			
Item	**Description**	**Operation**	**Display**
Set Temperature Range Limit	Set temperature range limit for cooling, heating, or auto mode.	Each Group	Each Group

.9 CMCN Remote Controllers: System Integration

.1 The CMCN shall be capable of supporting integration with Building Management Systems (BMS).

.2 BACnet® Integration: BACnet® hardware, which is built into all networked central controllers, shall be compliant with BACnet® Protocol (ANSI/ASHRAE 135-2010) and be Certified by the (BTL) BACnet® Testing Laboratories. The BACnet® interface shall support BACnet Broadcast Management (BBMD). The BACnet® interface shall support a maximum of 50 indoor units. Operation and monitoring points include, but are not limited to, on/off, operation mode, fan speed, prohibit remote controller, filter sign reset, alarm state, error code, and error address.

.3 Licenses:

.1 LIC-BACnet Master: Master Controller license for Master Centralized Controller and Non Touch Screen, Networked Centralized Controller

.2 LIC-BACnet Expansion: Expansion Controller license for Expansion Controller and Non Touch Screen, Networked Centralized Controller

.4 LIC-BACnet Specifications:

.1 Control up to 50 groups

.2 1 to 16 indoor units can be collectively controlled in a group

.3 Supports dual set point functionality (connected model dependant)

.4 BTL Compliant

.5 BACnet communication specifications are based on ANSI/ASHRAE Standards 135-2010

.5 PC Requirements:

.1 CPU: 1GHz or higher

.2 Memory: 1GB or more

.3 HDD Space: 100 MB or more

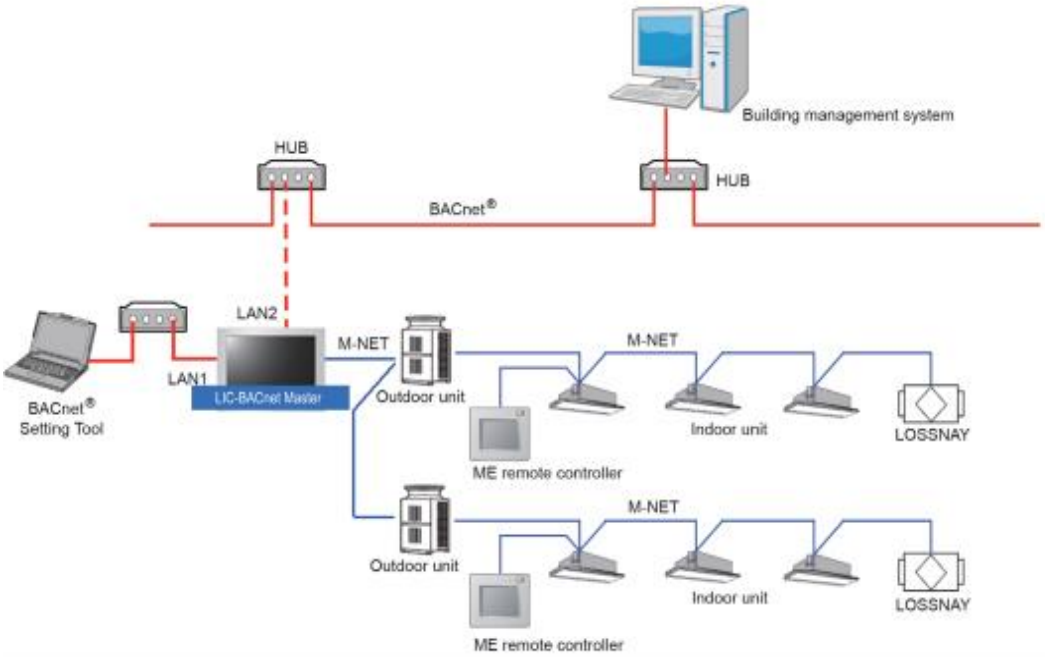
.4 Screen Resolution: 1024 x 768 or higher

.5 OS: Microsoft Windows 7 32-bit/64-bit, Microsoft 8.1 32-bit/64-bit. Not compatible with Windows Vista

.6 Execution Environment: Microsoft .NET Framework 4.5 or later

.7 Others: Pointing device such as a mouse, internet connection (required when installing a .NET Framework)

.6 LIC-BACnet – System Example



.7 BACnet Points List

On Off Setup
On Off State, Number of ON/OFF, Cumulative operation time
Alarm Signal (4-digit error code)
Error Code
Operational Mode Setup
Operational Mode State
Fan Speed Setup
Fan Speed State
Room Temp [Water Temp]
Set Temp [Set Water Temp]
Set Temp Cool
Set Temp Heat
Set Temp Auto
Filter Sign [Circulating Water Exchange Sign]
Filter Sign Reset [Circulating Water Exchange Sign Reset]
Prohibition On Off
Prohibition Mode

Prohibition Filter Sign Reset [Prohibition Circulating Water Exchange Sign Reset]
Prohibition Set Temperature
M-NET Communication State
System Forced Off
Air Direction Setup
Air Direction State
Set High Limit Setback Temp
Set Low Limit Setback Temp
Ventilation Mode Setup
Ventilation Mode State
Air To Water Mode Setup
System Alarm Signal (4-digit error code)
PI Controller Alarm Signal (4-digit error code)
Group Apportioned Electric Energy
Interlocked Units Apportioned Electric Energy
PI controller Electric Energy 1–4
Pulse Input Electric Energy 1–4
Group Apportionment Parameter
Interlocked Units Apportionment Parameter
Night Purge State
Thermo On Off State
Trend Log Room Temp
Trend Log Group Apportioned Electric Energy
Trend Log Interlocked Units Apportioned Electric Energy
Trend Log PI controller Electric Energy 1–4
Trend Log Pulse Input Electric Energy 1–4
Trend Log Group Apportionment Parameter
Trend Log Interlocked Units Apportionment Parameter

3 EXECUTION

3.1 AIR CONDITIONING - SPLIT SYSTEM

.1 Install indoor unit in accordance with manufacturer's installation instructions. Make all duct and piping connections necessary.

.2 Install outdoor unit plumb and level on concrete pad or wall mounted as required, making all necessary piping connections.

.3 Install refrigerant line kits in accordance with manufacturer's installation instructions.

.4 Refrigeration Equipment: prepare system for start-up by having manufacturer's field engineer or factory trained representative supervise testing, and charging of machines.

.5 Testing:

.1 Provide sufficient refrigerant, dry nitrogen and refrigeration oil for pressure and operational testing under manufacturer's supervision.

.2 Prior to testing ensure that system is complete. Protect relief valves during test procedure. After completion of test, reconnect and make good piping connections and leak the entire test system.

.6 Power wiring under Division 26.

.7 Control wiring under this Section.

END OF SECTION

1. GENERAL

1.1 SUMMARY

.1 Section Includes.

.1 Methods and procedures for start-up, verification and commissioning, for building Energy Monitoring and Control System (EMCS) and includes:

.1 Start-up testing and verification of systems.

.2 Check out demonstration or proper operation of components.

.3 On-site operational tests.

.2 Related Requirements

.1 Section 25 05 01.

1.2 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.

1.3 DESIGN REQUIREMENTS

.1 Confirm with Consultant 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.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01330 - Submittal Procedures.

.2 Final Report: submit report to Consultant.

.1 Include measurements, final settings and certified test results.

.2 Bear signature of commissioning technician and supervisor

.3 Report format to be approved by Consultant 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 Consultant 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.

1.5 CLOSEOUT SUBMITTALS

.1 Provide documentation, O&M Manuals, and training of O&M personnel for review of Consultant before interim acceptance in accordance with Section 01 78 00 - Closeout Submittals.

1.6 COMMISSIONING

.1 Do commissioning in accordance with Section 01 91 13 - GENERAL COMMISSIONING REQUIREMENTS.

.2 Carry out commissioning in presence of Consultant.

.3 Inform, and obtain approval from, Consultant 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 Consultant 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.

1.7 COMPLETION OF COMMISSIONING

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

1.8 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.

2. PRODUCTS

2.1 EQUIPMENT

.1 Provide sufficient instrumentation to verify and commission the installed system. Provide two-way radios.

.2 Instrumentation accuracy tolerances: higher order of magnitude than equipment or system being tested.

.3 Independent testing laboratory to certify test equipment as accurate to within approved tolerances no more than two(2) months prior to tests.

.4 Locations to be approved, readily accessible and readable.

.5 Application: to conform to normal industry standards.

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 Commissioning Agent.

.3 Commission integrated systems using procedures prescribed by Commissioning Agent.

.4 Debug system software.

.5 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.

.6 Test full scale emergency evacuation and life safety procedures including operation and integrity of smoke management systems under normal and emergency power conditions as applicable.

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 Consultant.

.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.

.7 After setting, test zero and span in 10 % increments through entire range while both increasing and decreasing pressure.

.8 Consultant 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 Consultant. 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 Commissioning Agent and provide:

.1 Two technical personnel capable of re-calibrating field hardware and modifying software.

.2 Detailed daily schedule showing items to be tested and personnel available.

.3 Consultants 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 Consultant.

.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.

.2 Test to last at least 30 consecutive 24 hour days.

.3 Tests to include:

.4 System will be accepted when:

.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 Consultant to verify reported results.

3.3 ADJUSTING

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

3.4 DEMONSTRATION

.1 Demonstrate to Commissioning Agent operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks and lock-outs in accordance with Section 01 79 00 - Demonstration and Training.

END OF SECTION

1. GENERAL

1.1 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for training program, instructors and training materials, for building Energy Monitoring and Control System (EMCS) Work.

.2 Related Requirements

.1 Section 25 05 01.

1.2 DEFINITIONS

.1 CDL - Control Description Logic.

.2 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 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 Consultant 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 each phase of training program that training has been satisfactorily completed.

1.4 QUALITY ASSURANCE

.1 Provide competent instructors thoroughly familiar with aspects of EMCS installed in facility.

.2 Consultant reserves right to approve instructors.

1.5 INSTRUCTIONS

.1 Provide instruction to designated personnel in adjustment, operation, maintenance and pertinent safety requirements of EMCS installed.

.2 Training to be project specific.

1.6 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).

1.7 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).

1.8 TRAINING PROGRAM

.1 To be in 2 phases over six month period.

.2 Phase 1: two day program to begin before 30 day test period at time mutually agreeable to Contractor, Owner, Commissioning Agent and Consultant.

.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, 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: Five 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 within 5 day period in following subjects in approximate percentages of total course shown:

Software and architecture: 10%
Application programs: 15%
Controller programming: 50%
Trouble shooting and debugging:10%
Colour graphic generation: 15%

1.9 ADDITIONAL TRAINING

.1 List courses offered by name, duration and approximate cost per person per week. Note courses recommended for training supervisory personnel.

1.10 MONITORING OF TRAINING

.1 Consultant to monitor training program and may modify schedule and content.

2. PRODUCTS

2.1 NOT USED

.1 Not Used.

3. EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION

1. GENERAL

1.1 SUMMARY

.1 Section Includes:

.1 General requirements for building Energy Monitoring and Control System (EMCS) that are common to NMS EMCS Sections.

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

.1 Safety Data Sheets (SDS).

.9 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, 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 Consultant prior to installation.

.3 Location of controllers as reviewed by Consultant prior to installation.

.4 Provide utility 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:

.1 Input and output commands and messages from operator-initiated functions, field related changes and alarms as defined in CDL's or assigned limits (i.e. commands relating to day-to-day operating functions and not related to system modifications, additions, or logic re-definements).

.2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points.

.3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

1.6 SHOP DRAWING SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures and 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

.2 Submit for review:

.1 Equipment list and systems manufacturers within 10 days after award of contract.

.2 List existing field control devices to be re-used included in bid, along with unit price.

.3 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: Shop Drawings, Product Data 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 Consultant, 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 Consultant.

.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 seven year guarantee of availability of spare parts after obsolescence.

.4 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.

1.8 DELIVERY, STORAGE AND HANDLING

.1 Material Delivery Schedule: provide Consultant with schedule within two weeks after award of Contract.

.2 Waste Management and Disposal:

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

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Place materials defined as hazardous or toxic in designated containers.

.4 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional, and Municipal regulations.

.5 Label location of salvaged material's storage areas and provide barriers and security devices.

.6 Ensure emptied containers are sealed and stored safely.

1.9 EXISTING- CONTROL COMPONENTS

.1 Utilize existing control wiring and piping as indicated.

.2 Re-use field control devices that are usable in their original configuration provided that they conform to applicable codes, standards specifications.

.1 Do not modify original design of existing devices without written permission from Consultant.

.2 Provide for new, properly designed device where re-usability of components is uncertain.

.3 Inspect and test existing devices intended for re-use within 30 days of award of contract, and prior to installation of new devices.

.1 Furnish test report within 40 days of award of contract listing each component to be re-used and indicating whether it is in good order or requires repair.

.2 Failure to produce test report will constitute acceptance of existing devices by contractor.

.4 Non-functioning items:

.1 Provide with report specification sheets or written functional requirements to support findings.

.2 Repair or replace existing items judged defective yet deemed necessary for EMCS.

.5 Submit written request for permission to disconnect controls and to obtain equipment downtime before proceeding with Work.

.6 Assume responsibility for controls to be incorporated into EMCS after written receipt of approval from Consultant.

.1 Be responsible for repair costs due to negligence or abuse of equipment.

.7 Remove existing controls not re-used or not required. Place in approved storage for disposition as directed.

2. PRODUCTS

2.1 EQUIPMENT

.1 Control Network Protocol and Data Communication Protocol: to CEA 709.1 and ASHRAE STD 135.

.2 Complete list of equipment and materials to be used on project and forming part of bid documents by adding manufacturer's name, model number and details of materials, and submit for approval.

2.2 ADAPTORS

.1 Provide adaptors between metric and imperial components.

3. EXECUTION

3.1 MANUFACTURER'S RECOMMENDATIONS

.1 Installation: to manufacturer's recommendations.

3.2 PAINTING

.1 Painting: in accordance with Section 09 91 23 - Interior Painting, supplemented as follows:

.1 Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.

.2 Restore to new condition, finished surfaces too extensively damaged to be primed and touched up to make good.

.3 Clean and prime exposed hangers, racks, fastenings, and other support components.

.4 Paint unfinished equipment installed indoors to EEMAC 2Y-1.

END OF SECTION

1. GENERAL

1.1 SUMMARY

.1 Section Includes.

.1 Methods and procedures for shop drawings submittals, preliminary and detailed review process including review meetings, for building Energy Monitoring and Control System (EMCS).

.2 Related Requirements:

.1 Section 25 05 01.

1.2 DEFINITIONS

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

1.3 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 sub-contractors and site-specific key personnel.
.7 Sketch of site-specific system architecture.
.8 Specification sheets for each item including memory provided, programming language, speed, 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.

1.4 SHOP DRAWING 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 Consultant.

1.5 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, other data to establish compliance.

.2 Detailed system architecture showing all points associated with each controller including, signal levels, pressures where new EMCS ties into existing control equipment.

.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, 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.

.10 Compressor schematic and sizing data.

1.6 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 air and water 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.

1.7 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 Consultant retains right to revise sequence or subsequent CDL prior to software finalization without cost to Owner.

2. PRODUCTS

2.1 NOT USED

.1 Not Used.

3. EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION

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.

.2 Related Requirements

.1 Section 25 05 01.

1.2 DEFINITIONS

.1 BECC - Building Environmental Control Centre.

.2 OWS - Operator Workstation.

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

1.3 SHOP DRAWING SUBMITTALS

.1 Submittals in accordance with Section 01 78 00 - Closeout Procedures, supplemented and modified by requirements of this Section.

1.4 AS-BUILTS

.1 Provide 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, telephone numbers of each sub-contractor 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 Consultant.

.3 Provide before acceptance 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 two complete sets of hard and soft copies prior to system or equipment tests

.3 Include complete coverage in concise language, readily understood by operating personnel using common terminology of functional and operational requirements of system. Do not presume knowledge of computers, electronics or in-depth control theory.

.4 Functional description to include:

- .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 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 co-ordination of hardware and software changes, data link or message format/content changes, sensor or control changes in event that system modifications are required.

.9 Programmer control panel documentation: provide where panels are independently interfaced with BECC, including interfacing schematics, signal identification, timing diagrams, fully commented source listing of applicable driver/handler.

2. PRODUCTS

2.1 NOT USED

.1 Not Used.

3. EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION

1. 4aGENERAL

1.1 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for identification of devices, sensors, wiring tubing, conduit and equipment, for building Energy Monitoring and Control System (EMCS) Work and nameplates materials, colours and lettering sizes.

.2 Related Requirements

.1 Section 25 05 01.

1.2 REFERENCE STANDARDS

.1 CSA Group (CSA).

.1 CSA C22.1-02, The Canadian Electrical Code, Part I (19th Edition), Safety Standard for Electrical Installations.

1.3 DEFINITIONS

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

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 Consultant for approval samples of nameplates, identification tags and list of proposed wording.

2. PRODUCTS

2.1 NAMEPLATES FOR PANELS

.1 Identify by plastic laminate, 3 mm thick Melamine, matte 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 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 Consultant.

.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 Consultant.

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 PNEUMATIC TUBING

.1 Numbered tape markings on tubing to provide uninterrupted tracing capability.

2.7 CONDUIT

.1 Colour code EMCS conduit.

.2 Pre-paint box covers and conduit fittings.

.3 Coding: use fluorescent orange paint and confirm colour with Consultant during "Preliminary Design Review".

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.

3.2 EXISTING PANELS

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

END OF SECTION

1. GENERAL

1.1 GENERAL REQUIREMENTS

.1 Refer to Section 25 01 01.

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 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 and OWS's including main control centre BECC.

.4 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.

.5 Refer to wiring diagrams included as part of flow diagrams. Trace existing control wiring installation and provide updated wiring schematics including additions and/or deletions to control circuits for approval by engineer before commencing work.

.2 Mechanical:

.1 Pipe Taps Required for EMCS equipment will be supplied and installed by Division.

.2 Wells and Control Valves 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.

.3 VAV Terminal Units.

.1 Air flow probe for vav boxes to be supplied and installed under Section 23 36 00 - Air Terminal Units, Air flow differential sensor, actuator and associated vav controls to be supplied and installed by EMCS contractor. Tubing from air probe to differential pressure 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.

.4 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 Cutting and Patching: refer to Section 01 73 00 - Execution supplemented as specified herein.

.2 Repair all surfaces damaged during execution of work.

.3 Turn over to Consultant existing materials removed from work not identified for re-use.

2. PRODUCTS

2.1 PIPING

.1 Domestic H&CWS: refer to Section 22 11 16

.2 Sanitary, storm water: refer to Section 22 13 16.13 and 22 13 16.16

.3 Hot water heating, chilled water, and condenser water: refer to Section 23 21 13.01 and 23 21 13.02.

.4 Refrigeration: refer to Section 23 23 00.

.5 Sleeves, escutcheons: refer to Section 22 11 19.

.6 Hangers and supports: refer to Section 22 05 00 and 23 05 29.

.7 Insulation: refer to Section 22 07 19, 23 07 13, 23 07 16, and 23 07 19.

2.2 SPECIAL SUPPORTS

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

2.3 PIPING FOR PNEUMATIC CONTROL SYSTEMS

.1 Copper:

.1 Tubing: ASTM B88.

.1 Fittings: wrought copper solder type to ANSI/ASME B16.22, and 95.5 antimonial tin solder. At instruments use compression fittings.

.2 At panels and junction boxes where there is a transition from plastic to copper use bulkhead fittings.

.2 Plastic:

.1 Flame retardant, black PVC with minimum burst strength 1.3 MPa at 23°C installed in conduit.

.2 Fittings: compression or barbed type as required.

2.4 WIRING

.1 As per requirements of Division 26.

.2 For 70V and above copper conductor with chemically cross-linked thermosetting polyethylene insulation rated RW90 and 600V. Colour code to CSA 22.1.

.3 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. All other cases use FT4 wiring.

.4 Sizes:

.1 120V 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: #18 AWG or 20 AWG stranded twisted pair.

.4 Analog input and output: shielded #18 minimum solid copper or #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.

2.5 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, 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.

2.6 WIRING DEVICES, COVER PLATES

.1 Conform to CSA.

.2 Receptacles:

.1 Duplex: CSA type 5-15R.

.2 Single: CSA type 5-15R.

.3 Cover plates and blank plates: finish to match other plates in area.

2.7 STARTERS, CONTROL DEVICES

.1 Across-the-line magnetic starters:

.1 Enclosures: CSA Type 1, except where otherwise specified.

.2 Size, type and rating: to suit motors.

.2 Starter diagrams:

.1 Provide copy of wiring and schematic diagrams - mount one copy in each starter with additional copies for operation and maintenance manual.

.3 Auxiliary Control Devices:

.1 Control transformers: 60 Hz, primary voltage to suit supply, 120 V single phase secondary, VA rating to suit load plus 20% margin.

.2 Auxiliary contacts: one "Normally Open" and one "Normally Closed" spare auxiliary contact in addition to maintained auxiliary contacts as indicated.

.3 Hand-Off-Automatic switch: heavy duty type, knob lever operator.

.4 Double voltage relays: with barrier to separate relay contacts from operating magnet. Operating coil voltage and contact rating as indicated.

.4 Finish for starters:

.1 Exterior: in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Interior: white.

2.8 SUPPORTS FOR CONDUIT, FASTENINGS, 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.

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 MECHANICAL PIPING

.1 Install piping straight, parallel and close to building structure with required grades for drainage and venting.

.2 Ream ends of pipes before assembly.

.3 Copper tubing not to come into contact with dissimilar metal.

.4 Use non-corrosive lubricant or Teflon tape on male screwed threads.

.5 Clean ends of pipes, tubing and recesses of fittings to be brazed or soldered. Assemble joints without binding.

.6 Install di-electric couplings where dissimilar metals joined.

.7 Sleeves:

.1 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.

.2 Caulking:

.1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.

.2 Elsewhere: provide space for fire stopping by Section 07 84 00 - Fire Stopping. 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.

.8 Pressure tests:

.1 Pressure test piping systems modified under this contract to 1 1/2 times maximum working pressure or 860 kPa (whichever is greater) for 4 hours without loss of pressure.

.2 Isolate equipment, components, not designed to withstand test pressure.

.9 Introduce system pressure carefully into new piping.

3.3 SUPPORTS

.1 Install special supports as required and as indicated.

3.4 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 contacts and mark to prevent accidental injury.

.3 Do underground installation to CAN/CSA-C22.3 No.7, except where otherwise specified.

.4 Conform to manufacturer's recommendations for storage, handling and installation.

.5 Check factory connections and joints. Tighten where necessary to ensure continuity.

.6 Install electrical equipment between 1000 and 2000 mm above finished floor wherever possible and adjacent to related equipment.

.7 Protect exposed live equipment such as panel, mains, outlet wiring during construction for personnel safety.

.8 Shield and mark live parts "LIVE 120 VOLTS" or other appropriate voltage.

.9 Install conduits, and sleeves prior to pouring of concrete.

.10 Holes through exterior wall and roofs: flash and make weatherproof.

.11 Make necessary arrangements for cutting of chases, drilling holes and other structural work required to install electrical conduit, cable, pull boxes, outlet boxes.

.12 Install cables, conduits and fittings which are to be embedded or plastered over, neatly and closely to building structure to minimize furring.

3.5 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 Consultant before starting such work. Provide complete conduit system to link field panels and devices with main control centre. Conduit size to match conductors plus future expansion capabilities as specified.

.4 Locate conduits at least 150 mm from parallel steam or hot water pipes and at least 50 mm at crossovers.

.5 Bend conduit so that diameter is reduced by less than 1/10th original diameter.

.6 Field thread on rigid conduit to be of sufficient length to draw conduits up tight.

.7 Limit conduit length between pull boxes to less than 30 m.

.8 Use conduit outlet boxes for conduit up to 32 mm diameter and pull boxes for larger sizes.

.9 Fastenings and supports for conduits, cables, and equipment:

.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 Consultant.

.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 Consultant 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.

3.6 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 Consultant 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.

3.7 WIRING DEVICES, COVER PLATES

.1 Receptacles:

.1 Install vertically in gang type outlet box when more than one receptacle is required in one location.

.2 Cover plates:

.1 Install suitable common cover plate where wiring devices are grouped.

.2 Use flush type cover plates only on flush type outlet boxes.

3.8 STARTERS, CONTROL DEVICES

.1 Install and make power and control connections as indicated.

.2 Install correct over-current devices.

.3 Identify each wire, terminal for external connections with permanent number marking identical to diagram.

.4 Performance Verification:

.1 Operate switches and controls to verify functioning.

.2 Perform start and stop sequences of contactors and relays.

.3 Check that interlock sequences, with other separate related starters, equipment and auxiliary control devices, operate as specified.

3.9 GROUNDING

.1 Install complete, permanent, continuous grounding system for equipment, including conductors, connectors and accessories.

.2 Install separate grounding conductors in conduit within building.

.3 Install ground wire in all PVC ducts and in tunnel conduit systems.

.4 Tests: perform ground continuity and resistance tests, using approved method appropriate to site conditions.

3.10 TESTS

.1 General:

.1 Perform following tests in addition to tests specified Section 25 08 20 - EMCS: Warranty and Maintenance.

.2 Give 14 days written notice of intention to test.

.3 Conduct in presence of Consultant and authority having jurisdiction.

.4 Conceal work only after tests satisfactorily completed.

.5 Report results of tests to Consultant in writing.

.6 Preliminary tests:

.1 Conduct as directed to verify compliance with specified requirements.

.2 Make needed changes, adjustments, replacements.

.3 Insulation resistance tests:

3.11 IDENTIFICATION

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

END OF SECTION

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).

.2 Related Requirements

.1 Section 25 05 01.

.3 References.

.1 CSA Group (CSA).

.1 CSA Z204-94(R1999), Guidelines for Managing Indoor Air Quality in Office Buildings.

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 SHOP DRAWING SUBMITTALS

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

.2 Submit detailed preventative maintenance schedule for system components to Consultant.

.3 Submit detailed inspection reports to Consultant.

.4 Submit dated, maintenance task lists to Consultant. 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 Consultant, after inspection indicating that planned and systematic maintenance have been accomplished.

.7 Revise and submit to Consultant 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.

1.4 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 Provide telephone number where service personnel may be reached at any time.

.4 Service personnel to be on site ready to service EMCS two 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 Consultant.

1.5 SERVICE CONTRACTS

.1 Provide in-depth technical expertise and assistance to Consultant 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 field points for operation and calibration.

.2 4 visits per year.

.3 4 responses to emergency calls during day, per year.

.4 4 responses to emergency calls during silent hours per year.

.5 Silent hours defined as 18:00 to 8:00.

.6 Complete inventory of installed system.

2. PRODUCTS

2.1 NOT USED

.1 Not Used.

3. EXECUTION

3.1 FIELD QUALITY CONTROL

.1 Perform as minimum (3) three minor inspections and one major inspection (more often if required by manufacturer) per year. Provide detailed written report to Consultant 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 field 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 Consultant 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

1. GENERAL

1.1 SUMMARY

.1 Section Includes:

.1 System requirements for Local Area Network (LAN) for Building Energy Monitoring and Control System (EMCS).

.2 Related Requirements

.1 Section 25 05 01.

1.2 REFERENCE STANDARDS

.1 CSA Group (CSA).

.1 CSA T529-95(R2000), Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/TIA/EIA-568-A with modifications).

.2 CSA T530-99(R2004), Commercial Building Standard for Telecommunications Pathways and Spaces (Adopted ANSI/TIA/EIA-569-A with modifications).

.2 Institute of Electrical and Electronics Engineers (IEEE)/Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements.

.1 IEEE Std 802.3™-2002, Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.

.3 Telecommunications Industries Association (TIA)/Electronic Industries Alliance (EIA)

.1 TIA/EIA-568-March 2004, Commercial Building Telecommunications Cabling Standards Set, Part 1 General Requirements Part 2 Balanced Twisted-Pair Cabling Components Part 3 Optical Fiber Cabling Components Standard.

.2 TIA/EIA-569-A-December 2001, Commercial Building Standard for Telecommunications Pathways and Spaces.

.4 Treasury Board Information Technology Standard (TBITS).

.1 TBITS 6.9-2000, Profile for the Telecommunications Wiring System in Government Owned and Leased Buildings - Technical Specifications.

1.3 DEFINITIONS

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

1.4 SYSTEM DESCRIPTION

.1 Data communication network to link Operator Workstations and Master Control Units (MCU) in accordance with CSA T529, TIA/EIA-568, CSA T530, TIA/EIA-569-A, and TBITS 6.9.

.1 Provide reliable and secure connectivity of adequate performance between different sections (segments) of network.

.2 Allow for future expansion of network, with selection of networking technology and communication protocols.

.2 Data communication network to include, but not limited to:

.1 EMCS-LAN.

.2 Modems.

.3 Network interface cards.

.4 Network management hardware and software.

.5 Network components necessary for complete network.

1.5 DESIGN REQUIREMENTS

.1 EMCS Local Area Network (EMCS-LAN).

.1 High speed, high performance, local area network over which MCUs and OWSs communicate with each other directly on peer to peer basis in accordance with IEEE 802.3/Ethernet Standard.

.2 EMCS-LAN to: BACnet.

.3 Each EMCS-LAN to be capable of supporting at least 50 devices.

.4 Support of combination of MCUs and OWSs directly connected to EMCS-LAN.

.5 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, upload/download information between network devices. Bit rate to be 100 Megabits per second minimum.

.6 Detection and accommodation of single or multiple failures of either OWSs, MCUs or network media. Operational equipment to continue to perform designated functions effectively in event of single or multiple failures.

.7 Commonly available, multiple sourced, networking components and protocols to allow system to co-exist with other networking applications including office automation.

.2 Dynamic Data Access.

.1 LAN to provide capabilities for OWSs, either network resident or connected remotely to access point status and application report data or execute control functions for other devices via LAN.

.2 Access to data to be based upon logical identification of building equipment.

.3 Network Medium.

.1 Network medium: twisted cable, shielded twisted cable, or fibre optic cable compatible with network protocol to be used within buildings. Fibre optic cable to be used between buildings.

2. PRODUCTS

2.1 NOT USED

.1 Not Used.

3. EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION

1. GENERAL

1.1 SUMMARY

.1 Section Includes:

.1 Materials and installation for building automation controllers including:

.1 Master Control Unit (MCU).

.2 Local Control Unit (LCU).

.3 Equipment Control Unit (ECU).

.4 Terminal Control Unit (TCU).

.2 Related Requirements

.1 Section 25 05 01.

1.2 REFERENCE STANDARDS

.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE).

.1 ASHRAE Applications Handbook (latest edition).

.2 CSA Group (CSA).

.1 C22.2 No.205, Signal Equipment.

.3 Institute of Electrical and Electronics Engineers (IEEE).

.1 IEEE C37.90.1, Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.

1.3 DEFINITIONS

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

1.4 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 Consultant 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 use of router interconnection with remote access points.

1.5 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:

.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:

.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 degrees C to 44 degrees 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 Consultant 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.

1.6 SHOP DRAWING SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures and Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

.1 Submit product data sheets for each product item proposed for this project.

1.7 MAINTENANCE

.1 Provide manufacturers recommended maintenance procedures for insertion in Section 25 05 03 - EMCS: Project Record Documents.

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 OWS(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 64 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. RAM to be downline loadable from OWS.

.4 Include uninterruptible clock accurate to plus or minus 1 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 specified in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.

.1 Mount access/display panel in MCU or in suitable enclosure beside MCU as approved by Consultant.

.2 Support operator's terminal for local command entry, instantaneous and historical data display, programs, additions and modifications.

.3 Display simultaneously minimum of 32 point identifiers to allow operator to view single screen dynamic displays depicting entire mechanical systems.

.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: same as OWS user password and 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. Use same point identifier as at OWS's for access of points at OT to eliminate cross-reference or look-up tables.

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 two 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 (70V 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 OWS 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 OWS.

.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 Consultant.

.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 OWS. 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) from OWS.

.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 OWS 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 analyse 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 analyse 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 OWS. 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 Cold deck reset.
.12 Hot deck reset.
.13 Hot water reset.
.14 Chilled water reset.
.15 Condenser water reset.
.16 Chiller sequencing.
.17 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 Consultant.

.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 one min or less for analog inputs.

.5 Totalization to provide calculations and storage of accumulations up to 99,999.9 units (eg. 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 OWS as selected by operator.

.1 Display analog values digitally to one 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.

3. EXECUTION

3.1 LOCATION

.1 Location of Controllers to be approved by Consultant.

3.2 INSTALLATION

.1 Install Controllers in secure locking enclosures.

.2 Provide necessary power from local 120V 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

1. GENERAL

1.1 SUMMARY

.1 Section Includes:

.1 Control devices integral to the Building Energy Monitoring and Control System (EMCS): transmitters, sensors, controls, meters, switches, transducers, dampers, damper operators, valves, valve actuators, and low voltage current transformers.

.2 Related Sections:

.1 Section 01 73 00 - Execution.

.2 Section 07 84 00 - Fire stopping.

.3 Section 23 33 15 - Dampers - Operating.

.4 Section 25 01 11 - EMCS: Start-Up, Verification and Commissioning.

.5 Section 25 05 01 - EMCS: General Requirements.

.6 Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

.7 Section 25 05 54 - EMCS: Identification.

.8 Section 25 90 01 - EMCS: Site Requirements Applications and Systems Sequences of Operation.

.9 Section 26 05 00 - Common Work Results for Electrical.

.10 Section 26 27 10 - Modular Wiring System.

.11 Section 26 27 26 - Wiring Devices.

1.2 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI).

.1 ANSI C12.7 Requirements for Watthour Meter Sockets.

.2 ANSI/IEEE C57.13, Standard Requirements for Instrument Transformers.

.2 ASTM International (ASTM)

.1 ASTM B148, Standard Specification for Aluminum-Bronze Sand Castings.

.3 National Electrical Manufacturer's Association (NEMA).

.1 NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

.4 Air Movement and Control Association, Inc. (AMCA).

.1 AMCA Standard 500-D, Laboratory Method of Testing Dampers For Rating.

.5 CSA Group CSA Group

.1 CSA-C22.1, Canadian Electrical Code, Part 1 (19th Edition), Safety Standard for Electrical Installations.

1.3 DEFINITIONS

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

1.4 SHOP DRAWING SUBMITTALS

.1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 25 05 02 - EMCS: Submittals and Review Process.

.2 Pre-Installation Tests.

.1 Submit samples at random from equipment shipped, as requested by Consultant 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.

1.5 EXISTING CONDITIONS

.1 Cutting and Patching: in accordance with Section 01 73 00 - Execution Requirements supplemented as specified herein.

.2 Repair surfaces damaged during execution of Work.

.3 Turn over to Owner existing materials removed from Work not identified for re-use.

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, heat resistant assembly.

.3 Operating conditions: 0-40°C with 95% 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 Provide devices installed in user occupied space that do not exceed Noise Criteria (NC) of 35. Noise generated by any device must not be detectable above space ambient conditions.

.9 Range: including temperature, humidity, pressure, as indicated in I/O summary in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.

2.2 TEMPERATURE SENSORS

.1 General: except for room sensors to be resistance or thermocouple type to following requirements:200

.1 Thermocouples: limit to temperature range of 200°C and over.

.2 RTD's: 100 or 1000 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 degrees 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 150 mm as indicated.

.2 Room temperature sensors and display wall modules.

.1 Temperature sensing and display wall module.

.1 LCD display to show space temperature ed and temperature setpoint.

.2 Buttons for occupant selection of temperature setpoint and occupied/unoccupied mode.

.3 Jack connection for plugging in laptop personal computer contractor supplied zone terminal unit for access to zone bus.

.4 Integral thermistor sensing element 10,000 ohm at 24 degrees.

.5 Accuracy 0.2 degrees C over range of 0 to 70 degrees C.

.6 Stability 0.02 degrees C drift per year.

.7 Separate mounting base for ease of installation.

.2 Room temperature sensors.

.1 Wall mounting, in slotted type covers having brushed stainless steel finish, with guard

.2 Element 10-50mm long RTD with ceramic tube or equivalent protection or thermistor, 10,000 ohm, accuracy of plus or minus 0.2 degrees C.

.3 Duct temperature sensors:

.1 General purpose duct type: suitable for insertion into ducts at various orientations, insertion length 460 mm.

.2 Averaging duct type: incorporates numerous sensors inside assembly which are averaged to provide one reading. Minimum insertion length 6096 mm. Bend probe at field installation time to 100 mm radius at point along probe without degradation of performance.

.4 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 1000 ohm at 0 degrees C, platinum resistance detector type sensors.

.2 Power supply: 24 VDC into load of 575 ohms. Power supply effect less than 0.01 degrees 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 1000 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 degrees 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 degrees C to plus 50 degrees C, plus or minus 0.5 degrees C.

.2 0 to 100 degrees C, plus or minus 0.5 degrees C.

.3 0 to 50 degrees C, plus or minus 0.25 degrees C.

.4 0 to 25 degrees C, plus or minus 0.1 degrees C.

.5 10 to 35 degrees C, plus or minus 0.25 degrees C.

2.4 HUMIDITY SENSORS

.1 Room and Duct Requirements:

- .1 Range: 5 - 90% RH minimum.
- .2 Operating temperature range: 0 - 60 degrees C.
- .3 Absolute accuracy:
  - .1 Duct sensors: plus or minus 3%.
  - .2 Room sensors: plus or minus 2%.
- .4 Sheath: stainless steel with integral shroud for specified operation in air streams of up to [10] m/s.
- .5 Maximum sensor non-linearity: plus or minus 2% RH with defined curves.
- .6 Room sensors: locate as indicated.
- .7 Duct mounted sensors: locate so that sensing element is in air flow in duct.

.2 Outdoor Humidity Requirements:

- .1 Range: 0 - 100% RH minimum.
- .2 Operating temperature range: -40 - 50 degrees C.
- .3 Absolute accuracy: plus or minus 2%.
- .4 Temperature coefficient: plus or minus 0.03%RH/ degrees C over 0 to 50 degrees C.
- .5 Must be unaffected by condensation or 100% saturation.
- .6 No routine maintenance or calibration is required.

2.5 HUMIDITY TRANSMITTERS

.1 Requirements:

- .1 Input signal: from RH sensor.
- .2 Output signal: 4 - 20 mA onto 500 ohm maximum load.
- .3 Input and output short circuit and open circuit protection.
- .4 Output variations: not to exceed 0.2 % of full scale output for supply voltage variations of plus or minus 10 %.
- .5 Output linearity error: plus or minus 1.0% maximum of full scale output.
- .6 Integral zero and span adjustment.
- .7 Temperature effect: plus or minus 1.0 % full scale/ 6 months.
- .8 Long term output drift: not to exceed 0.25 % of full scale output/ 6 months.

2.6 PRESSURE TRANSDUCERS

.1 Requirements:

.1 Combined sensor and transmitter measuring pressure.

.1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.

.2 Output signal: 4 - 20 mA into 500 ohm maximum load.

.3 Output variations: less than 0.2 % full scale for supply voltage variations of plus or minus 10 %.

.4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5 % of full scale output over entire range.

.5 Temperature effects: not to exceed plus or minus 1.5% full scale/ 50 degrees C.

.6 Over-pressure input protection to at least twice rated input pressure.

.7 Output short circuit and open circuit protection.

.8 Accuracy: plus or minus 1% of full scale.

2.7 DIFFERENTIAL PRESSURE TRANSMITTERS

.1 Requirements:

.1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.

.2 Output signal: 4 - 20 mA into 500 ohm maximum load.

.3 Output variations: less than 0.2% full scale for supply voltage variations of plus or minus 10%.

.4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5% of full scale output over entire range.

.5 Integral zero and span adjustment.

.6 Temperature effects: not to exceed plus or minus 1.5% full scale/ 50 degrees C.

.7 Over-pressure input protection to at least twice rated input pressure.

.8 Output short circuit and open circuit protection.

.9 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

2.8 STATIC PRESSURE SENSORS

.1 Requirements:

.1 Multipoint element with self-averaging manifold.

.1 Maximum pressure loss: 160 Pa at 10 m/s. (Air stream manifold).

.2 Accuracy: plus or minus 1% of actual duct static pressure.

2.9 STATIC PRESSURE TRANSMITTERS

.1 Requirements:

.1 Output signal: 4 - 20 mA linear into 500 ohm maximum load.

.2 Calibrated span: not to exceed 150% of duct static pressure at maximum flow.

.3 Accuracy: 0.4% of span.

.4 Repeatability: within 0.5% of output.

.5 Linearity: within 1.5% of span.

.6 Deadband or hysteresis: 0.1% of span.

.7 External exposed zero and span adjustment.

.8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit

2.10 VELOCITY PRESSURE SENSORS

.1 Requirements:

.1 Multipoint static and total pressure sensing element with self-averaging manifold with integral air equalizer and straightener section.

.2 Maximum pressure loss: 37 Pa at 1000 m/s.

.3 Accuracy: plus or minus 1% of actual duct velocity.

2.11 VELOCITY PRESSURE TRANSMITTERS

.1 Requirements:

.1 Output signal: 4 - 20 mA linear into 500 ohm maximum load.

.2 Calibrated span: not to exceed 125 % of duct velocity pressure at maximum flow.

.3 Accuracy: 0.4% of span.

.4 Repeatability: within 0.1% of output.

.5 Linearity: within 0.5% of span.

.6 Deadband or hysteresis: 0.1% of span.

.7 External exposed zero and span adjustment.

.8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

2.12 LIQUID AND STEAM FLOW METERS

.1 Requirements:

.1 Pressure rating: as specified in I/O summaries.

.2 Temperature rating: as specified in I/O summaries.

.3 Repeatability: plus or minus 0.2 %.

.4 Accuracy and linearity: plus or minus 1.0%.

.5 Flow rangability: at least 10:1.

.6 Body material: cast or ductile iron.

.7 Ends:

.1 NPS 2 and under: screwed.

.2 NPS 2.1/2 and over: flanged.

2.13 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES

.1 Requirements:

.1 Internal materials: suitable for continuous contact with compressed air, water, steam, etc., as applicable.

.2 Adjustable setpoint and differential.

.3 Switch: snap action type, rated at 120V, 15 amps AC or 24 V DC.

.4 Switch assembly: to operate automatically and reset automatically when conditions return to normal. Over-pressure input protection to at least twice rated input pressure.

.5 Accuracy: within 2% repetitive switching.

.6 Provide switches with isolation valve and snubber, where code allows, between sensor and pressure source.

.7 Switches on steam and high temperature hot water service: provide pigtail syphon.

2.14 TEMPERATURE SWITCHES

.1 Requirements:

.1 Operate automatically. Reset automatically, except as follows:

.1 Low temperature detection: manual reset.

.2 High temperature detection: manual reset.

.2 Adjustable setpoint and differential.

.3 Accuracy: plus or minus 1 degrees C.

.4 Snap action rating: 120V, 15 amps or 24V DC as required. Switch to be DPST for hardwire and EMCS connections.

.5 Type as follows:

.1 Room: for wall mounting on standard electrical box with or without protective guard as indicated.

.2 Duct, general purpose: insertion length = 460 mm.

.3 Thermowell: stainless steel, with compression fitting for NPS 3/4 thermowell. Immersion length: 100 mm.

.4 Low temperature detection: continuous element with 6096 mm insertion length, duct mounting, to detect coldest temperature in any 30 mm length.

.5 Strap-on: with helical screw stainless steel clamp.

2.15 TANK LEVEL SWITCHES

.1 Requirements:

.1 Indicate high/low water level and to alarm.

.2 For mounting on top of tank.

.3 Maximum operating temperature: 120 degrees C.

.4 Snap action contacts rated 15 amp at 120 V.

.5 Adjustable setpoint and differential.

2.16 SUMP LEVEL SWITCHES

.1 Requirements:

.1 Liquid level activated switch sealed in waterproof and shockproof enclosure.

.2 Complete with float, flexible cord, weight. Instrument casing to be suitable for immersion in measured liquid.

.3 N.O./N.C. Contacts rated at 15 amps at 120V AC. CSA approval for up to 250 volt 10 amps AC.

2.17 WIND VELOCITY TRANSMITTERS

.1 Requirements:

.1 3-cup anemometer and airfoil vane mounted on common vertical axis, designed for mast mounting.

.2 Anemometer:

.1 Range: 0-160 km/h.

.2 Threshold: 3.0 km/h.

.3 Accuracy: +/- 2%.

.3 Airfoil vane

.1 Range: 0-360 degrees with infinite resolution potentiometer with no loss of reading at transition point.

.2 Starting threshold: 1.1 M/s.

.3 Accuracy: +/- 0.5%.

.4 Output signals: 4 to 20mA into 500 ohm load.

.5 Provide two output signals: velocity, direction.

.6 Mast: aluminum, size and height as indicated.

2.18 SOLAR SENSORS

.1 Monitor solar radiation as indicated.

.2 Pyranometer, black and white, producing proportional 0-50 mV signal. Include converter for 4-20 mA signal.

2.19 CURRENT / PNEUMATIC (I/P) TRANSDUCERS

.1 Requirements:

.1 Input range: 4 to 20 mA.

.2 Output range: proportional 20-104 kPa or 20-186 kPa as applicable.

.3 Housing: dustproof or panel mounted.

.4 Internal materials: suitable for continuous contact with industrial standard instrument air.

.5 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 2% of full scale over entire range.

.6 Integral zero and span adjustment.

.7 Temperature effect: plus or minus 2.0 % of full scale/ 50degrees C or less.

.8 Regulated supply pressure: 206 kPa maximum.

.9 Air consumption: 16.5 ml/s maximum.

.10 Integral gauge manifold c/w gauge (0-206 kPa).

2.20 SOLENOID CONTROL AIR VALVES

.1 Coil: 120V AC or 24V DC, as indicated.

.2 Capacity: to pass a minimum of 0.15 l/s air at 140 kPa differential.

2.21 AIR PRESSURE GAUGES

.1 Diameter: 38 mm minimum.

.2 Range: zero to two times operating pressure of measured pressure media or nearest standard range.

2.22 ELECTROMECHANICAL RELAYS

.1 Requirements:

.1 Double voltage, DPDT, plug-in type with termination base.

.2 Coils: rated for 120V AC or 24V DC. Other voltage: provide transformer.

.3 Contacts: rated at 5 amps at 120 V AC.

.4 Relay to have visual status indication

2.23 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 degrees C to 70 degrees C.

.5 Relays to be CSA Certified.

.6 Input/output Isolation Voltage to be 4000 VAC at 25 degrees 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.

2.24 CURRENT TRANSDUCERS

.1 Requirements:

.2 Purpose: combined sensor/transducer, to measure line current and produce proportional signal in one of following ranges:

.1 4-20 mA DC.

.2 0-1 volt DC.

.3 0-10 volts DC.

.4 0-20 volts DC.

.3 Frequency insensitive from 10 - 80 hz.

.4 Accuracy to 0.5% full scale.

.5 Zero and span adjustments. Field adjustable range to suit motor applications.

.6 Adjustable mounting bracket to allow for secure/safe mounting inside MCC.

2.25 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.

2.26 CONTROL DAMPERS

.1 Construction: blades, 152 mm wide, 1219 mm long, maximum. Modular maximum size, 1219 mm wide x 1219 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 1000 Pa static pressure for outdoor air and exhaust air applications.

.3 Temperature range: minus 40 degrees C to plus 100 degrees 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 manufacturers installation guidelines.

.4 Use same manufacturer as damper sections.

2.27 PNEUMATIC CONTROL DAMPER ACTUATORS

.1 Requirements:

.1 Piston type with spring return for "fail-safe" in Normally Open or Normally Closed position, as indicated.

.2 Operator: size to control dampers against maximum pressure and dynamic opening/closing pressure, whichever is greater.

.3 Adjustable spring and stroke external stops to limit strokes in either direction.

.4 For modulating applications provide with full relay type positioner with interconnecting linkage for mechanical feedback. Adjust to operate between range of 20-90 kPa unless otherwise indicated in control sequence of operation or input/output summary sheet.

.5 Positioners not required on single damper sections with less than 1 m^2 face area.

2.28 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.

2.29 CONTROL VALVES

.1 Body: globe style or characterized ball.

.1 Flow characteristic as indicated on control valve schedule: linear, equal percentage, or quick opening.

.2 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.

.3 Normally open or normally closed as indicated.

.4 Two or Three 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.

.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 or 250 as indicated cast iron lugged body installed in locations as indicated. For steam and heating water ANSI Class 150 or 250 as indicated carbon steel lugged body.

.2 Extended stem neck to provide adequate clearance for flanges and insulation.

.3 Pressure limit: bubble tight sealing to [170] kilopascals.

.4 Disc/vane: 316 stainless steel.

.5 Seat: for service on chilled water [PTFE (polytetrafluoroethylene)], [EPDM (ethylene propylene diene monomer)]. For service on steam and heating water [PTFE], [RTFE (reinforced PTFE)].

.6 Stem: 316 stainless steel.

.7 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.

.8 Flow characteristic linear.

.9 Maximum flow requirement as indicated on control valve schedule.

.10 Maximum pressure drop as indicated on control valve schedule: pressure drop not to exceed one half of inlet pressure.

.11 Normally open or normally closed, as indicated.

.12 Valves are to be provided complete with mounting plate for installation of actuators.

2.30 PNEUMATIC VALVE ACTUATORS

.1 Requirements:

.1 Construction: steel, cast iron, aluminum.

.2 Diaphragm: moulded Buna-N rubber, nylon reinforced.

.3 Spring return to normal position.

.4 Spring range adjustment and position indicator.

.5 Provide pilot positioners on modulating control valves over 50 mm and where indicated on drawings and I/O summary. Positioners to operate between 20 to 90 kPa unless otherwise noted or required by sequence.

.6 Minimum shut-off pressure: refer to control valve schedule.

2.31 ELECTRONIC / ELECTRIC VALVE ACTUATORS

.1 Requirements:

.1 Construction: steel, cast iron, aluminum.

.2 Control signal: 0-10V DC or 4-20 mA 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.

2.32 WATTHOUR METERS AND CURRENT TRANSFORMERS

.1 Requirements:

.1 Include three phases, test and terminal blocks for watthour metre connections and connections for monitoring of current. Provide two transformers for 600 V 3 wire systems for watthour metre use. Accuracy: plus or minus 0.25] % of full scale. For chiller applications: to have instantaneous indicator with analog or digital display.

.2 Watthour metre sockets: to ANSI C12.7.

.3 Potential and current transformers: to ANSI/IEEE C57.13.

.4 Potential transformers: provide two primary fuses.

.5 Demand meters: configure to measure demand at [15] minute intervals.

2.33 SURFACE WATER DETECTORS

.1 Requirements:

.1 Provide alarm on presence of water on floor.

.2 Expendable cartridge sensor.

.3 Internal waterproof switch.

.4 One set of dry contacts 2 amps at 24 V.

.5 Unaffected by moisture in air.

.6 Self-powered.

2.34 PANELS

.1 Enamelled steel cabinets with hinged and key-locked front door.

.2 Additional space to accommodate 25% additional capacity as required without adding additional cabinets.

.3 Panels to be lockable with same key.

2.35 CONTROL AIR COMPRESSOR STATIONS

.1 Requirements: provide 2 high pressure, base mounted, each complete with belts, guards, intake muffler, replaceable cartridge intake cleaner, starter, pressure switches, alternator.

.2 Capacity: size to maintain air pressure, meet control air requirements on 25% maximum running time.

.3 Receiver: size to suit running time. Complete with electronic automatic drain with strainer, pressure relief valve, pressure gauge ASME code rated for 1400 kPa.

.4 Vibration isolation: 5% transmissibility.

.5 Refrigerated air drier:

.1 Two continuous operating type, complete with refrigerant evaporator, mechanical condensate separator, installed with 2 isolating valves. Designed for 1400 kPa maximum operating pressure.

.2 Capacity: sized for full capacity of compressors, to reduce dewpoint to minus 10 degrees C when dehydrating at 700 kPa. Maximum pressure drop 19 kPa at rated capacity.

.3 Provide 2 filter and PRV assemblies, with isolating valves and filter element, having 99% efficiency in removal of 0.5 micron diameter solid particles and oil aerosols and with indication of degree of saturation. Piping: ensure one dryer is always in circuit and active.

2.36 WIRING

.1 In accordance with Section 26 27 10 - Modular Wiring System or 26 27 26 - Wiring Devices as applicable.

.2 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. Other cases use FT4 wiring.

.3 Wiring must be continuous without joints.

.4 Sizes:

.1 Field wiring to digital device: #18AWG or 20AWG stranded twisted pair.

.2 Analog input and output: shielded #18 minimum solid copper or #20 minimum stranded twisted pair.

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 in accordance with Section 07 84 00 - 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 in Section [25 90 01 - EMCS: Site Requirements Applications and Systems Sequences of Operation or on drawings. Trace existing control wiring installation and provide updated wiring schematics including additions, deletions to control circuits for review by Consultant before beginning Work.

.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. Consultant to review before starting Work. Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit.

.7 Pneumatic: provide Pneumatic tubing, valves and fittings for field control devices in accordance with Section 23 09 43 - Pneumatic Control System for HVAC.

.8 Mechanical: supply and install in accordance with Section 23 09 43 - Pneumatic Control System for HVAC.

.1 Pipe Taps.

.2 Wells and Control Valves.

.3 Air flow stations, dampers, and other devices.

.9 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 MAGNEHELIC PRESSURE INDICATORS

.1 Install adjacent to fan system static pressure sensor and duct system velocity pressure sensor as reviewed by Consultant.

.2 Locations: as indicated.

3.5 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.

3.6 I/P TRANSDUCERS

.1 Install air pressure gauge on outlet.

3.7 AIR PRESSURE GAUGES

.1 Install pressure gauges on pneumatic devices, I/P, pilot positioners, motor operators, switches, relays, valves, damper operators, valve actuators.

.2 Install pressure gauge on output of auxiliary cabinet pneumatic devices.

3.8 IDENTIFICATION

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

3.9 AIR FLOW MEASURING STATIONS

.1 Protect air flow measuring assembly until cleaning of ducts is completed.

3.10 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

1. GENERAL

1.1 SUMMARY

.1 Section Includes:

.1 At minimum detailed narrative description of Sequence of Operation of each system including ramping periods and reset schedules.

.1 Control Description Logic (CDL) for each system.

.2 Input/Output Point Summary Tables for each system.

.3 System Diagrams consisting of the following: EMCS System architectural diagram, Control Design Schematic for each system (as viewed on OWS), System flow diagram for each system with electrical ladder diagram for MCC starter interface.

1.2 REFERENCE STANDARDS

.1 Public Works and Government Services Canada (PWGSC) / Real Property Branch / Architectural and Engineering Services.

.1 MD13800, Energy Management and Control Systems (EMCS) Design Manual.

1.3 SEQUENCING

.1 Sequencing of operations for systems as follows:

.1 As shown on drawings.

2. PRODUCTS

2.1 NOT USED

.1 Not Used.

3. EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION

1 GENERAL

1.1 INSTRUCTIONS

.1 Comply with the General Conditions of the Contract, the Supplementary Conditions, and Division 01 – General Requirements.

1.2 SUMMARY

.1 This Section specifies requirements and instructions that are common to Electrical Division of the Specification and it is a supplement to each section and is to be read accordingly.

.1 Any item or subject which is shown, mentioned, or reasonably implied on either drawings or in the specifications, is considered to be properly and sufficiently specified and shown; and must be provided. Provide all material, labour, equipment, tools, consumables, etc. required to complete all the work of the Electrical Division

.2 These common works relate to all scope of work related within the Electrical Divisions which incorporates:

.1 Electrical Drawings

.2 Division 26 Electrical specification

.3 Division 27 Communications specifications

.4 Division 28 Electronic Safety and Security specifications

.3 These common works also have the following Sections which are applicable to all Sections within this Division and supplement this Section:

.1 26 05 03 – Electrical Work Testing

.2 26 05 53 – Identification for Electrical Systems

.2 Products furnished/supplied but not installed under this Section:

.1 Supply to Division 09 installer the access doors. Provide location where these doors and orientation these doors should be installed.

.3 Related sections: The following is included for reference only and shall not be presumed complete:

.1 Division 02 Existing Conditions

.2 Division 03 Cast-in-Place Concrete

.3 Division 09 Finishes

.4 Division 26 Electrical

.5 Division 27 Communications

.6 Division 28 Electronic Safety and Security

1.3 PRICE AND PAYMENT PROCEDURES

.1 Measurement and Payment:

.1 If a change to the work is requested, the Contractor to submit pricing for the change including an itemized list of the associated material and labour changes and costs. Apply mark-up as indicated in the Contract.

.2 A change must be approved by the Contractor before the work is to proceed. If work is performed without such approval, it is performed at the Contractor's or Sub-Contractors' risk.

.3 In the event of a disagreement by the Contractor over valuation of the change in work, resolution will follow the procedure outlined below:

.1 Labour hours are derived using the RSMeans Electrical Costing Book.

.2 Labour rates are as stated in the Instructions to Bidders.

.3 Material prices are "Trade" prices provided by a local supplier or distributor.

.4 Material requirements are obtained from field measurements.

.5 Major equipment prices are reasonably negotiated.

.2 Progress Payment Breakdown:

.1 Submit, prior to submittal of the first progress payment draw, a breakdown of the cost of the electrical work to assist the Consultant in reviewing and approving monthly progress payment claims.

.2 The payment breakdown is subject to the Consultant's approval and progress payments will not be processed until an approved breakdown is in place. The breakdown is to include one-time claim items such as mobilization and demobilization, insurance, bonds (if applicable), shop drawings and product data sheets, commissioning, and project closeout submittals.

.3 Breakdown to include the following line items as a minimum:

.1 Job costs (permits, bonds, mobilization, supervision, and job foreman)

.2 Excavation, backfill, concrete

.3 Hydro Service (main secondary ductbank and netering)

.4 Distribution and service (panels, feeders, and main service)

.5 Mechanical equipment wiring (to include starters, motor control centres, disconnect switches, and wiring)

.6 Electric heating

.7 Branch wiring (to include devices, cover plates, installation, and wiring)

.8 Lighting (to include fixtures, poles, mounting, installation, and wiring)

.9 Emergency lighting system (to include battery units, exit lights, remote fixtures, and wiring)

.10 Lighting control system

.11 Extra-low voltage pathways (to include wireways, conduits, sleeves, ductbank, and firestopping)

.12 Structured Cabling System (to include cabling, outlets, patch panels, racks, and telecommunication grounding)

.13 Video surveillance system rough-in

.14 Access control system rough-in

.15 Intrusion alarm systems rough-in

.16 Fire alarm system

.17 Miscellaneous equipment, systems, and associated wiring

1.4 REFERENCES

.1 Definitions:

.1 The following are definitions of words found in electrical work Sections of the Specification and on associated drawings:

.1 "concealed" – means work hidden from normal sight in furred spaces, shafts, tunnels, ceiling spaces, walls and partitions

.2 "exposed" – means work normally visible, including work in electrical and equipment rooms and similar spaces

.3 "provide" (and tenses of provide) – means supply and install complete

.4 "install" (and tenses of install) – means install and connect complete

.5 "supply" – means supply only

.6 "finished area" - means any area or part of an area which receives a finish such as paint, or is factory finished

.7 "governing authority" and/or "regulatory authority" and/or "Municipal authority" – means all government departments, agencies, standards, rules and regulations that apply to and govern the electrical work and to which the work must adhere

.8 "Consultant" – means the Architect or Consulting Engineer who has prepared the Contract Documents on behalf of the Owner

.2 Wherever the words "indicated", "shown", "noted", "listed", or similar words or phrases are used in the specification they are understood, unless otherwise defined, to mean that the product referred to is "indicated", "shown", "listed", or "noted" on the drawings.

.3 Wherever the words "approved", "satisfactory", "as directed", "submit", "permitted", "inspected" or similar words or phrases are used in the specification or on the drawings they are understood, unless otherwise defined, to mean that work or product referred to is "approved by", "inspected by", etc., the Consultant.

.4 In the electrical specification, singular may be read as plural, and vice-versa.

.2 Reference Standards: Versions of the following standards current as of the date of issue of the project apply to the Work of this Division. Where regulatory requirements use older version of a standard, comply with the version year adopted by the Authority Having Jurisdiction

.1 American National Standards Institute (ANSI):

.1 ANSI/ASHRAE/IES 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings

.2 Canadian Standards Association (CSA):

.3 Underwriters Laboratories of Canada (ULC):

.1 CAN/ULC-S1001 – Standard for Integrated Systems Testing

1.5 ADMINISTRATIVE REQUIREMENTS

.1 Plan work well in advance to eliminate delivery, installation and co-ordination difficulties. Be held equally responsible with other Sections or Divisions to resolve interferences and to co-operate with other Sections to satisfactorily complete the project. Being there first will not be accepted as a legitimate reason.

.2 Examination of site and documents:

.1 When estimating the cost of the work and prior to submitting a bid for the work carefully examine all the bid documents and visit the site to determine and review all existing site conditions that will or may affect the work and include for all such conditions in the bid price.

.2 Report to the Consultant, prior to bid submittal, any existing site condition that will or may affect performance of the work as per the drawings and specifications. Failure to do so will not be grounds for additional costs.

.3 Drawings and Specification:

.1 Read the electrical work drawings in conjunction with all work drawings including but not limited to civil, landscaping, structural, architectural, sprinkler, and mechanical.

.2 The electrical drawings are performance drawings, diagrammatic, and show approximate locations of equipment and connecting services. Any information regarding accurate measurement of the building is to be taken at the site. Do not scale the drawings, and do not use the drawings for prefabrication work.

.3 The drawings are intended to convey the scope of work and do not show architectural and structural details. Include cost for all offsets, fittings, transformations, and similar products required as a result of obstructions and other civil, architectural and structural details but not shown on the drawings.

.4 The locations of equipment and materials shown may be altered, when reviewed by the Consultant. Include cost to meet requirements of the equipment and/or materials, other equipment or systems being installed, and of the building.

.5 Sections of the Electrical Division are not intended to delegate functions nor to delegate work and supply of materials to any specific trade, but rather to generally designate a basic unit of work, and the Sections are to be read as a whole.

.6 The electrical specification does not generally indicate the specific number of items or extent of material required. The specification is intended to provide product data and installation requirements. It is necessary to refer to drawing schedules, layouts, schematic diagrams, riser diagrams, and details to determine correct quantities.

.7 The electrical drawings and specification are intended to be cooperative. Perform all work that is shown, specified, or reasonably implied on the drawings but not mentioned in the specification, or vice-versa, as though fully covered by both.

.8 When the scale and date of the drawings are the same, or when the discrepancy exists within the specification, the costliest arrangement will take precedence.

.9 In the case of discrepancies between the drawings and specifications, the documents will govern in the order specified in the General Conditions, however, when the scale and date of the drawings are the same, or where the discrepancy exists within the specification, the costliest arrangement will take precedence.

.4 Coordination:

.1 Relation to other sections:

.1 Provide all excavations, trenching, backfilling and compaction required for the Electrical Divisions at the Division's expense, unless otherwise specified or shown. Backfill all excavations in layers with clean materials 100 mm (4 in) sand bed and cover for direct buried conduit and be power compacted to a minimum 95% proctor 100% within building perimeter) unless specified to be higher elsewhere. Restore to original condition all surfaces, landscaping, etc., disturbed by excavation work. Provide all this work in accordance with Division 03 Earthwork Methods. When working inside the building perimeter or near existing services, protect existing construction and services to prevent damage; hand excavate where applicable.

.2 Provide all cutting and patching required for the Section work by the appropriate trade at the expense of the Electrical Division, unless otherwise specified or shown. Refer to the Architectural Specifications and drawings for details of cutting and patching provisions and requirements.

.3 Provide all sleeves, inserts, hangers and core drilling of slabs, etc., required for completion of the Section work. Coordinate the location of inserts, sleeves, hangers, holes, back boxes, tubs, junction boxes, etc., with the respective Section into whose materials they are being installed. Extend all floor and roof sleeves 100 mm (4 in) above the finished levels, unless noted otherwise. Complete all roof sleeves with roof flashing and rain shields to ensure a weatherproof seal.

.4 Cut holes and install sleeves for electrical installations piercing fire, smoke, thermal, exterior, and acoustic separations to minimum sizes.

.1 Seal all gaps on both sides of the separation by a qualified tradesman using materials and methods described in the applicable specification section, to maintain the appropriate rating, acoustic, thermal bridge, or water resistance. All costs for such will be paid for by the Electrical Division.

.2 If an existing penetration is not properly sealed to these standards, either provide new penetration for work and seal appropriately, or seal entire opening including existing penetrations. Where multiple Divisions are penetrating the same separation, group services and share sealing costs where appropriate.

.5 Provide all concrete bases and reinforcing required for electrical equipment housekeeping pads inside the building by Division 03 unless otherwise shown or specified at the expense of the Electrical Division. Accurate templates, dimensions, detail, etc., will be provided by the Electrical Division for proper location and size. Provide all other cast-in-place concrete and reinforcing required for work of the Electrical Division, such as duct banks and fixture bases, by the Electrical Division, unless otherwise indicated. Provide all cast-in-place concrete and reinforcing of the Electrical Division will be provided in accordance with Division 03 Cast-in-place Concrete.

.6 Where access doors are required for electrical installations, supply types with self opening screwdriver lock and positive latching mechanism to the appropriate Division 09 subtrade for installation by them in the walls or ceiling. Pay all cost for installation by Division 09. Access doors are required where electrical equipment is located behind non-accessible surfaces and where access to, or servicing of the equipment is necessary. The access door size and fire rating must be approved by the Contractor. Refer to the Architectural Specifications for details of access door installation requirements. Provide installations to avoid the need for access doors where indicated.

.7 Deliver all electrical equipment and fixtures to the site with the specified finish. Provide touch up painting of electrical equipment scratched on site. Finish painting of primed electrical equipment and all concealed or exposed conduit, boxes, etc., as required will be provided by Division 09. Where finish painting and priming is within existing exposed ceiling, cost to be carried by this Division.

.8 Immediately wrap and seal in plastic “bubble” wrap all fixtures, equipment, and system components delivered to the site and not contained in sealed cardboard cartons. Following installation, the items will be protected from dirt, dust, and damage with similar plastic wrap or protective enclosures until energized and put into full operation.

.9 Coordinate installation of switches, thermostats, and other devices together at one common location with installing Sections and obtain approval on site from the Contractor of exact arrangement.

.5 Seismic control and restraint

.1 Provide seismic control and restraint as per Section 26 05 48 – Vibration and Seismic Control for Electrical Systems.

.6 Sequencing:

.1 Phasing of the Work:

.1 Phasing of the work is required to maintain the existing building in operation, all as specified in Division 01. Include all costs for phasing the work including all required "off hours" premium time labour costs.

.7 Planning and layout of the work, and associated drawings:

.1 Properly plan, coordinate, and establish the locations and routing of services with all subcontractors affected prior to installation such that the services will clear each other as well as any obstructions, including structural components of the building. Unless otherwise specified, the order of right-of-way for services is to be as follows:

.1 piping requiring uniform pitch

.2 piping 100 mm (4 in) diameter and larger

.3 large ducts (main runs)

.4 electrical cable tray and bus duct

.5 conduit 100 mm (4 in) diameter and larger

.6 piping less than 100 mm (4 in) diameter

.7 smaller branch ductwork

.8 conduit less than 100 mm (4 in) diameter

.2 Unless otherwise shown or specified, conceal all work in finished areas, and conceal work in partially finished or unfinished areas to the extent made possible by the area construction. Install conduit, raceway, and similar services as high as possible to conserve headroom and/or ceiling space. Install cable tray used for extra-low voltage cables as low as possible where removable finished ceilings are installed. Notify the Consultant where headroom or ceiling space appears to be inadequate prior to installation of the work.

.3 Revise or alter the arrangement of work that has been installed without proper coordination, study and review, even if it was completed in accordance with the Contract Documents, in order to conceal the work behind finishes, or to allow the installation of other work, at no additional cost. In addition, pay for the cost of alterations in other work required by the alterations to your work.

.4 All junction boxes, equipment and similar products, particularly such products located above suspended ceilings must be located for easy access for servicing and/or removal. Products which do not meet this location requirement are to be relocated to an accessible location at no additional cost.

.8 Permits, Fees, And Certificates:

.1 Apply for, obtain and pay for all permits required to complete the electrical work.

.2 Submit to the Consultant, all approval/inspection certificates issued by governing authorities to confirm that the work as installed is in accordance with the rules and regulations of the governing authorities. Pay any costs associated with issue of the certificates.

.9 Workplace Safety:

.1 Comply with requirements of the Workplace Hazardous Materials Information System (WHMIS) regarding the use, handling, storage, and disposal of hazardous materials. Submit WHMIS MSDS (Material Safety Data Sheets) for all products where required and maintain one copy at the site in a visible and accessible location available to all personnel.

.2 Comply with all requirements of Occupational Health and Safety Regulations and all other regulations pertaining to health and safety, including worker's compensation/ insurance board and fall protection regulations.

1.6 SUBMITTALS

.1 Submittals under this Division to be in accordance with Division 01 Submittal Procedures.

.2 Regulatory Communications:

.1 Forward to the Contractor copies of all correspondence and instructions from the Electrical Authority or any other Authority having Jurisdiction for clarification and action.

.3 Shop Drawings/Product Data:

.1 Shop drawings are those prepared specifically for the Project. Product data sheets are copies of manufacturer's standard catalogue or literature.

.2 Shop drawings and product data sheets must confirm that the product proposed meets all requirements of the Contract Documents.

.3 Submit for review Shop Drawings and Product Data sheets, in electronic PDF format, covering all items or equipment to be installed under the Contract (faxed and generic documents are not acceptable). Shop drawings and product data sheets to show all physical properties, relevant performance, and installation information. The drawings and data required to generally be as outlined under each Section of the Specification but will not be restricted to the items listed. Distribute reviewed Shop Drawings and data sheets to other relevant Sections as required for completion of their related work.

.4 All submitted Shop Drawings and data sheets must have been reviewed in detail by the Contractor and must bear their stamp. Should the drawings not have been reviewed and stamped, they will be rejected immediately.

.5 Each shop drawing or product data sheet is to be properly identified with the project name and the product drawing or specification reference, for example "Lighting Fixture F1", and all shop drawing or product data sheet dimensions are to be either metric or imperial to match dimensions on the drawings.

.6 Equipment will not be accepted on site until review of shop drawings and data sheets is complete. shop drawings or data sheets marked "Reviewed as Modified" are conditionally approved such that the Contractor to ensure equipment satisfies all Contract requirements. Delivery of equipment may proceed but final, corrected shop drawings and data sheets must be submitted prior to close of Contract.

.7 This review is for the sole purpose of ascertaining conformance with the general design concept. This review will not mean that the reviewer approves the detail design inherent in the shop drawing, responsibility for which will remain with the Section submitting same, and such review does not relieve the Electrical Division of their responsibility for efforts or omissions in the Shop Drawings and data sheets or of their responsibility for meeting all requirements of the Contract Documents. The Electrical Division is responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to the fabrication processes or to techniques of construction and installation, for all quantities indicated and for co-ordination of the work of all Sections.

1.7 CLOSEOUT SUBMITTALS

.1 Submittals under this Section shall be in conformance with Division 01 Closeout Procedures.

.2 Operation and Maintenance Manuals:

.1 Forward to the Contractor “Maintenance and Instruction Manuals” within four (4) weeks of substantial completion of the project.

.2 Provide all closeout submittals in a digital format. Organize all individual electronic documents in directories similar to the tabs in a binder and filenames in plain English describing of the contents within each file. Provide all documents in unsecured PDF format with searchable text. Provide all audio and video content encoded in a format that can be viewed using standard codecs freely available on the most current version of Microsoft Windows operating system.

.3 Each manual will contain, but not be restricted to, the following information:

.1 each shop drawing (revised as per the reviewed drawings)

.2 each product data sheet (revised as per the reviewed drawings)

.3 equipment parts list

.4 recommended list of spare parts

.5 operating and maintenance instructions

.6 equipment installation details, construction and performance data

.7 summary of all training provided including full training documents and audio-visual content

.8 list of all manufacturing and equipment service depots including address, email and telephone numbers

.9 Electrical Authority final inspection certificate

.10 emergency lighting test results

.11 fire alarm verification certificate and test report

.12 fire alarm audibility report

.13 integrated systems testing report

.14 cybersecurity reports

.15 telecommunications cabling test results including summary and comprehensive full results

.16 any other certificates, approval letters, etc.

.4 Provide qualified technicians to instruct the Owner's Representatives in the operation and maintenance of the systems and equipment included in the Electrical Division.

.3 Warranty Documents:

.1 Provide warranty documents in conformance with Division 01.

.2 The warranty period(s) commences on the date of Substantial Performance of the Work and shall be valid for the full duration specified.

.3 Submit warranties to the Consultant prior to Final Payment Certification.

.4 Record Documents:

.1 As-Built Drawings:

.1 During the progress of the work the Electrical Division will always keep on the site, a complete and separate set of prints and will note thereon clearly, neatly, accurately and promptly all Architectural, Structural, Mechanical and Electrical changes, revisions and additions to the work and deviations from the Contract Documents.

.2 Include accurate locations, depth, size, content, and type of all below grade pathways in these as-built drawings.

.3 Indicate also on the as-built drawings the location of access panels or removable ceiling tiles which cover equipment or junction boxes which may require future access or where conduit or wiring for future use is located.

.4 Prepare the final as-built drawings by a qualified draftsperson in AutoCAD at the contractor's expense as an electronic copy and one hard copy to be submitted to the Contractor at the completion of the project with an application for a Certificate of Total Performance.

.5 Submit as-built drawings in electronic format. All documents will be in both AutoCAD and unsecured PDF format.

.5 Software:

.1 Submit copies of all software and licences required for operation and maintenance of equipment provided. Work with owner's representative to install, set up, and configure provided software on designated workstations or servers. Install, set up, and configure provided firmware or operating systems on designated equipment.

.2 Provide to Owner's representative all configuration requirements prior to installation including temporary credentials with level of administration access required, operating system, list of IP addresses required with mapping to tag or unique description, firewall configurations, and any other information to successfully install software or equipment.

.3 Pay for any software, firmware and operating system subscription fees for the warranty period and setup online accounts in conjunction with Owner's representative.

.4 Provide all software, firmware, and operating system user guides, installation manuals, cybersecurity certificates, and documentation in unsecured searchable PDF format.

.5 Prior to warranty completion, update or upgrade all installed software to most current version compatible with equipment installed. During warranty period if any cybersecurity threats or known vulnerabilities to software are provided by the equipment manufacturer or relevant third-party software company, send immediate notification to Owner with instructions to patch or update software, firmware, or operating system.

1.8 QUALITY ASSURANCE

.1 Regulatory Requirements:

.1 All work carried out under this Contract will comply with, but not be limited to the requirements of the latest edition of the following codes and regulations:

.1 Ontario Electrical Safety Code complete with Bulletins and Amendments.

.2 Ontario Building Code complete with Supplemental Bulletins and its referenced standards.

.3 Applicable Standards from CSA, ULC, and from other standards organizations indicated herein.

.4 All applicable Federal, Provincial, Municipal and Industry standards and regulations.

.2 All electrical items are to be certified and bear the stamp or seal of a recognized testing agency such as CSA, UL, ULC, ETL, or bear a stamp to indicate special electrical authority approval.

.3 Requirements of the Contract Documents are to take precedence when they are more stringent than codes, ordinances, standards, and statutes.

.2 Qualifications:

.1 Installer's:

.1 Installer/Applicator/Erector to have a minimum of 5 years' continuous Canadian experience successfully completing projects similar in size and complexity as the Work of this Division. Submit proof of experience upon Consultant's request.

.2 Provide all work for Division 26 Electrical by qualified journeyman electricians or apprentices, holding valid provincial Certificates of Qualification, and be supervised by a competent foreman.

.3 Provide all work for Division 27 Communications and Division 28 Electronic Safety and Security by qualified technicians with documented certifications by manufacturers of equipment being installed and be supervised by a competent foreman.

.4 The work of the Electrical Division will be reflected in the quality of installations - any unsatisfactory installations will be removed and replaced accordingly.

.5 Provide all changes or alterations to the installations of this project required by an authorized Inspector of an Authority Having Jurisdiction in accordance with the terms and conditions of Contract.

.3 Certifications:

.1 Obtain all permits and certificates bearing upon this Trade and pay all fees and charges for same.

1.9 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials of this Division in accordance with Division 01.

1.10 PROJECT CONDITIONS

.1 Existing Conditions:

.1 Visit the site of the building and examine the existing conditions in relation to the work to be done. The Electrical Division to be responsible to allow for any requirements which could have been revealed during such examinations.

.2 Prepare a complete set of Interference drawings in co-ordination with other Sections for all typical or critical locations to indicate site installation conditions where space is limited. Use field measurements to indicate accurate dimensions and configurations of all Electrical services in relation to Structural and Architectural conditions as well as Mechanical services. Coordination with other Sections in the preparation of Drawings and layout of the related work is imperative. Submit these interference drawings to the Contractor for review prior to proceeding with any related work, according to normal Shop Drawing procedure.

1.11 WARRANTY

.1 All materials and installations of the Electrical Division will be guaranteed for a period of one year from the date of final acceptance of the work unless otherwise specified, regardless of the extent of equipment manufacturer's warranties.

2 PRODUCTS

2.1 MANUFACTURERS

.1 Alternate Manufacturers:

.1 In some sections of this specification, materials and equipment are specifically described and named by manufacturer for the purpose of establishing a minimum standard of materials, product quality and other specified requirements.

.2 The project systems design as per the Drawings and Specifications is based on the specified manufacturer's equipment but is intended to be appropriate for equivalent equipment of all other manufacturers contained listed in the Approved Manufacturers list within each Section.

.3 Products of manufacturers listed as "Alternates" are subject to product data and shop drawing review to ensure that they are equivalent to the products of the specified manufacturer. Alternate manufacturer's equipment will conform to the space limitations imposed by the project and the intent as outlined in this Specification and Drawings.

.4 The Electrical Division is encouraged to submit alternative proposals of manufacturers not listed in the Approved Manufacturers List of proposals or modified design with appropriate costs, delivery, and system design adjustments which they feel may be advantageous considerations for the project.

3 EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions:

.1 Examine all work of other Sections upon which the Work of each Section depends.

.2 Do not proceed with installation until all wet work such as concrete and painting has been completed and thoroughly dried.

.3 Report in writing to the Consultant/Project Manager any defects of surfaces or work prepared by other Sections which affect the quality or dimensions of the Work of each Section.

.4 Do not proceed with Work of each Section until all unsatisfactory conditions have been rectified and site conditions are ready to receive work.

.5 Commencement of work implies acceptance of existing conditions and work by other Sections.

3.2 PREPARATION

.1 Protection of in-place conditions:

.1 Provide temporary protection of adjacent areas and surfaces by means of masking (enclosures) where necessary to prevent contamination by Work of each Section.

3.3 INSTALLATION

.1 Installation of equipment:

.1 Unless otherwise specified all equipment is to be installed in accordance with the equipment manufacturer's recommendations and instructions, and requirements of governing Codes, Standards, and Regulations. Governing Codes, Standards, and Regulations take precedence over manufacturer's instructions.

.2 Ensure that proper access and service clearances are maintained around equipment, and, where applicable, access space for future equipment removal or replacement is not impeded. Remove and replace any equipment which does not meet this requirement.

.2 Scaffolding, Rigging, And Hoisting:

.1 Unless otherwise specified or directed, supply, erect and operate all scaffolding, rigging, hoisting equipment and associated hardware required for your work. Immediately remove from the site all scaffolding, rigging, and hoisting equipment when no longer required.

3.4 SITE QUALITY CONTROL

.1 Site Tests and Inspections:

.1 Conduct field inspection and testing as specified in Section 01 40 00

.2 Non-Conforming Work:

.1 Defective materials or quality of work, whenever found, at any time prior to acceptance of the work, shall be rejected regardless of previous inspection. Inspection will not relieve responsibility but is a precaution against oversight or errors.

.2 Replace damaged work which cannot be satisfactorily repaired, restored or cleaned, to the satisfaction of the Consultant at no additional cost to the Owner.

.3 Manufacturer Services:

.1 When equipment/system installation is complete, but prior to start-up procedures, arrange and pay for the equipment/system manufacturer's authorized representative to visit the site to examine the installation, and when any required corrective measures have been made, to certify in writing to the Consultant that the equipment/system installation is complete and in accordance with the equipment/system manufacturer's instructions.

3.5 SYSTEM STARTUP

.1 Preform all testing in accordance with Section 26 05 03 – Electrical Work Testing.

.2 Conduct acceptance tests to demonstrate that the equipment and systems meet the specified requirements. Conduct tests as soon as conditions permit. Make all changes, adjustments or replacements required as the preliminary tests may indicate.

.3 Operate all the equipment under normal conditions for a minimum period of five days as a start-up test. Defects disclosed must be repaired and tests repeated until pronounced satisfactory.

.4 Conduct final acceptance tests in the presence of the Contractor. Invite Consultant and Owner to attend with a minimum of one week's notification.

.5 Provide the services of one journeyman electrician and all ladders, tools, consumables, and associated equipment to assist the Contractor in carrying out the test.

3.6 ADJUSTING

.1 Adjust moving or operating parts to operate/function smoothly and properly.

3.7 CLEANING

.1 Clean work area daily in accordance with Division 01.

.2 Remove all excess materials from site as Work proceeds and at completion.

.3 On completion of the Work remove all tools, containers, surplus materials, equipment, waste, etc.; and leave site neat, clean, and tidy to the satisfaction of the Owner.

.4 Clean and make good surfaces soiled or otherwise damaged because of Work of each Section at no additional cost to the Owner.

.5 Leave surfaces clean and ready for subsequent Work.

3.8 CLOSEOUT ACTIVITIES

.1 Equipment and System Commissioning:

.1 Commission electrical equipment and systems in accordance with the Section 26 08 00 -Electrical Work Commissioning.

.2 Equipment and system Operation and Maintenance (O&M) demonstration and training:

.1 Refer to equipment and system operational and maintenance training requirements specified in Division 01.

.2 Train the Owner's designated personnel in all aspects of operation and maintenance of equipment and systems as specified in electrical work Sections of the Specification. All demonstrations and training is to be performed by qualified technicians employed by the equipment/system manufacturer/supplier.

.3 For each item of equipment and for each system for which training is specified, prepare training modules as specified below. Operating and Maintenance Manuals are to be used during the training sessions, and training modules are to include:

.1 Operational Requirements and Criteria: requirements and criteria are to include but not be limited to equipment function, stopping and starting, safeties, operating standards, operating characteristics, and limitations

.2 Troubleshooting: troubleshooting is to include but not be limited to diagnostic instructions, test and inspection procedures

.3 Documentation: documentation is to include but not be limited to equipment/system warranties, and manufacturer's/supplier's parts and service facilities, telephone numbers, email addresses, and the like

.4 Maintenance: maintenance requirements are to include but not be limited to inspection instructions, types of cleaning agents to be used as well as cleaning methods, preventive maintenance procedures, and use of any special tools

.5 Repairs: repair requirements are to include but not be limited to diagnostic instructions, disassembly, component removal and repair instructions, instructions for identifying parts and components, and review of any spare parts inventory

.4 Assemble the training modules into a training manual and submit a copy to the Consultant for review prior to scheduling training. Ensure that each participant in each training session has all required training material.

.5 Schedule demonstrations and training at mutually agreed to times with a minimum of 7 working days' notice.

.6 Demonstration and Training Confirmation: Obtain a list of personnel to receive demonstration and training from the Consultant, and have each participant sign the list to confirm that they understood the demonstration and training session.

3.9 PROTECTION

.1 Protect installed materials to prevent damage by other trades for the duration of the construction period. Use materials that may be easily removed without leaving residue or permanent stains.

END OF SECTION

1 GENERAL

1.1 INSTRUCTIONS

.1 Comply with the General Conditions of the Contract, the Supplementary Conditions, Division 01 – General Requirements, and Section 26 05 00 – Common Work Results for Electrical.

1.2 SUMMARY

.1 General Electrical Work Testing

.2 Distribution System Testing, Coordination Study and Arc Flash

2 PRODUCTS

2.1 NOT APPLICABLE

3 EXECUTION

3.1 INSTALLERS

.1 Testing Organization List:

.1 Distribution System Testing, Coordination Study and Arc Flash of the electrical distribution system equipment is to be performed by one of the following companies:

.1 Spark Power

.2 GT Wood

.3 EnKompass Power & Energy

.4 Brosz

3.2 SITE QUALITY CONTROL

.1 General Electrical Work Testing Requirements

.1 Satisfactorily perform all testing required by governing authorities, Codes, Regulation and the Specification, including general testing specified below. Prepare and sign test reports to confirm satisfactory completion of testing and submit as specified in Part 1 of this Section.

.2 Perform testing to suit phasing of the work, as applicable. Phasing shall be clearly marked at both the origin and destination end of the conductors. Where required, use a rotation meter/instrument to determine and confirm rotation is clockwise or counter-clockwise. This information shall be noted on the as-built drawings.

.3 Leaks, Grounds, and Crosses: After luminaries, switches, receptacles, motors, signals, and similar equipment has been installed, whether or not the work has been installed as part of the work of this Division of the Specification or by other Divisions (telephone system excepted), test the work to ensure that there are no leaks, grounds, or crosses.

.4 Motor Operation: Test and establish proper motor rotation, measure full load running currents, and check overload elements. Report to the Consultant any discrepancies that are found. Existing motors that have been disconnected and reconnected as part of the electrical work must be checked with rotation meter, and be responsible for any damage caused by reverse rotation.

.5 Branch Circuit Voltage Drop: Demonstrate to the Consultant that branch circuit voltage drop is within specified limits.

.6 Spares: Every fused protection shall provided with a minimum or 3 spares (one for each phase) and clearly marked for the device specific to the coordination study to ensure the proper fuse will be used if a replacement if needed.

.2 Distribution System Testing, Coordination Study and Arc Flash

.1 The electrical distribution system protective devices have been selected such that protection is adequate and proper coordination is possible, however, since differences do exist between manufacturers of equipment, some changes in trip ratings or relay settings may be necessary and are to be performed as part of the work, prior to energizing the electrical distribution system.

.2 Short Circuit and Coordination Study: Immediately upon notification of award of Contract, arrange for the testing company to perform the following:

.1 cooperate with and obtain from manufacturers of the distribution system equipment a list of equipment requiring protective devices to be used, and along with the manufacturers, ensure that proper control and protective devices are selected such that they can be properly coordinated

.2 prepare, as soon as possible, a set of coordination curves on proper time current characteristic graph paper and submit to the Consultant, accompanied by supporting symmetrical as well as asymmetrical fault current calculation data with tabulations to very protection of the various distribution system elements under maximum and minimum fault conditions at the various points in the system

.3 plot the time current characteristic curves for the following:

.1 main and feeder protective devices at voltage levels used in the distribution system

.2 protective devices associated with the largest motor in each motor control centre, the refrigeration machine compressors (as applicable), and the largest lead fed from each distribution panelboard

.3 emergency power engine generator set protective devices, damage curves, and current decrement curves

.4 where relays, breakers, etc., do not perform to approved coordination curves they are to be revised at no cost as part of the work

.3 The on-site test and coordination study of distribution system protective devices is to include, as applicable:

.1 testing, cleaning when necessary, and calibrating relays and circuit breaker trip devices (calibration) of protective devices is to conform to requirements of approved coordination (curves).

.2 a function test of associated control device

.3 replacement of any fuses destroyed during tests

.4 an acceptance test in the presence of and to the satisfaction of the Consultant

.5 the presence at the site, for the length of time required, of qualified equipment manufacturer's representatives

.6 an insulation resistance test of "load" side feeders with respect to ground

.7 testing of motor control centres, motor starters, and where supplied as part of the electrical work, viable speed drives

.4 Arc Flash Hazard Analysis: Perform an arc hazard analysis and prepare and submit a report with calculations to determine the flash protection boundary and the incident energy at locations in the electrical distribution system (switchboards, switchgear, motor control centres, distribution panelboards, bus duct, splitters), and other equipment where work could be performed on energized equipment. Include significant locations in systems fed from transformers 125 kVA and greater, and specify safe working distances for calculated fault locations based on the calculated arc flash boundary considering an incident energy of 1.2 cal/cm². Provide minimum 90 mm x 125 mm (3½ in x 5 in) thermal transfer type high adhesion polyester warning labels at each work location and piece of equipment analyzed. Labels are to have an orange header with machine printed wording warning, ARC FLASH HAZARD, and the following information:

.1 nominal voltage
.2 flash protection boundary
.3 hazard risk category
.4 incident energy
.5 working distance

END OF SECTION

1 GENERAL

1.1 INSTRUCTIONS

.1 Comply with the General Conditions of the Contract, the Supplementary Conditions and the General Requirements of Division 01 and Section 26 05 00 Common Work Results for Electrical.

1.2 SUMMARY

.1 This Section specifies requirements, criteria, methods and execution for electrical demolition work that are common to one or more electrical work Sections, and it is intended as a supplement to each Section and is to be read accordingly.

1.3 REFERENCES

.1 Reference Standards: Versions of the following standards current as of the date of issue of the project apply to the Work of this Section. Where regulatory requirements use older version of a standard, comply with the version year adopted by the Authority Having Jurisdiction

.1 Canadian Standards Association (CSA):

.1 CSA S350 Code of Practice for Safety in Demolition of Structures

2 PRODUCTS

2.1 NOT APPLICABLE

3 EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions:

.1 Examine all work of other Sections upon which the Work of this Section depends.

.2 Report in writing to the Consultant/Project Manager any defects of surfaces or work prepared by other Sections which affect the quality or dimensions of the Work of this Section.

.3 Do not proceed with Work of this Section until all unsatisfactory conditions have been rectified and site conditions are ready to receive work.

.4 Commencement of work implies acceptance of existing conditions and work by others.

3.2 PREPARATION

.1 Protection of In-Place Conditions:

.1 Provide temporary protection of adjacent areas and surfaces by means of masking (enclosures) where necessary to prevent contamination by Work of this Section.

.2 Disconnection and Removal of Existing Electrical Work

.1 Where indicated on the drawings, disconnect and remove existing electrical work, including hangers, supports, etc. Disconnect at the point of supply, remove obsolete connecting services and make the system safe. Cut back obsolete conduit behind finishes and cap unless otherwise specified.

.2 The scope and extent of the demolition or revision work is only generally indicated on the drawings. Estimate the scope, extent and cost of the work at the site during the bidding period scheduled site visit(s).

.3 Where deemed necessary by the Owner and Consultant, existing shafts, walls, and inaccessible ceilings will be opened by the Owner to permit site visit inspection of services to be removed/revised as part of the work but usually concealed behind such construction.

.4 Claims for extra costs for demolition work not shown or specified but clearly visible or ascertainable at the site during bidding period site visits will not be allowed.

.5 If any re-design is required due to discrepancies between the electrical drawings and site conditions, notify the Consultant who will issue a Site Instruction. If, in the opinion of the Consultant, discrepancies between the electrical drawings and actual site conditions are of a minor nature, the required modifications are to be done at no additional cost.

.6 Where existing electrical services extend through, or are in an area to serve items which are to remain, maintain the services in operation. Include for rerouting existing services concealed behind existing finishes and which become exposed during the renovation work, so as to be concealed behind new or existing finishes.

.7 Unless otherwise specified, remove from the site and dispose of all existing materials which have been removed and are not to be relocated or reused.

.8 Under no circumstance shall bare or unprotected conductors be left exposed in any area of removal or re-work. If temporary feeds are necessary, they shall meet ESA code regulations and be protected from contact and traffic during the period of transition or time left for re-working.

.3 Interruption to and Shut-Down of Electrical Services and Systems

.1 Co-ordinate all shut-down and interruption to existing electrical systems with the Owner. Generally, shut-downs may be performed only between the hours of 12:00 midnight Friday until 6:00 a.m. Monday morning.

.2 Upon award of contract, submit a list of anticipated shut-down times and their maximum duration.

.3 Prior to each shut-down or interruption, inform the Owner in writing seventy-two hours in advance of the proposed shut-down or interruption and obtain written approval to proceed. Do not shut-down or interrupt any system or service without such written approval.

.4 Perform work associated with shut-downs and interruptions as continuous operations to minimize the shut-down time and to reinstate the systems as soon as possible, and, prior to any shut-down, ensure that all materials and labour required to complete the work for which the shut-down is required are available at the site.

3.3 CLEANING

.1 Complete cleaning of this Section in accordance with Section 26 05 00 Common Work Results for Electrical.

3.4 PROTECTION

.1 Protect installed materials to prevent damage by other trades for the duration of the construction period. Use materials that may be easily removed without leaving residue or permanent stains.

END OF SECTION

1 GENERAL

1.1 INSTRUCTIONS

.1 Comply with the General Conditions of the Contract, the Supplementary Conditions, Division 01 – General Requirements, and Section 26 05 00 – Common Work Results for Electrical.

1.2 SUMMARY

.1 Section includes: Provide wire and cable, including but not limited to the following:

.1 This Section, "Wire and Cable", shall apply to all systems of this Contract. Variations or alterations of the requirements for a system, will be specified in that system section.

.2 Related sections: The following is included for reference only and shall not be presumed complete:

.1 Section 26 05 53 – Identification for Electrical Systems

.2 Section 26 05 33 – Raceway and Boxes for Electrical Systems

.3 Section 27 10 00 – Structured Cabling

2 PRODUCTS

2.1 MATERIALS

.1 Distribution And Branch Circuit Conductors

.1 Conductors to and including 10 AWG are to be solid or stranded type. Conductors larger than 8 AWG are to be stranded. All conductors are to be constructed from 98% conductive copper and are to be approved for 600 volts. Conductors are to be colour coded, factory identified on the insulation with the manufacturer's name, conductor size and metal, voltage rating, and CSA type and designation. Conductors are to be as follows:

.1 "T-90 Nylon" single conductor in accordance with CSA C22.2 No. 75, Thermoplastic-Insulated Wires and Cables, 90° C (195° F) rated, PVC insulated and nylon covered.

.2 "R-90" and "RW-90" single conductor in accordance with CAN/CSA C22.2 No. 38, Thermoset-Insulated Wires and Cable, 90° C (195° F) rated, X-link polyethylene insulated.

.3 "RWU-90" single conductor in accordance with CSA C22.2 No. 38, Thermoset-Insulated Wires and Cables, -40° C (-40° F) rated, X-link polyethylene insulated.

.4 "AC-90" flexible cable to CSA C22.2 No. 51, Armoured Cable, with 90° C (195° F) rated, X-linked polyethylene insulated conductors, a concentric ground conductor, and an interlocking aluminium armour jacket.

.5 "MI" ULC 2 hour fire rated conductor in accordance with CSA C22.2 No. 124, Mineral-Insulated Cable, 90° C (195° F) rated, consisting of a solid copper conductor, magnesium oxide insulation, a seamless soft drawn copper sheath, and terminations supplied by the cable manufacturer.

.6 Equal to Nexans Canada "Corflex" II RA90 flexible cable in accordance with requirements of CSA C22.2 No. 123, Aluminium Sheathed Cable, consisting of single or multiple copper conductors with X-link polyethylene insulation enclosed in a liquid and vapour-tight solid corrugated aluminium sheath and, as required, an overall PVC jacket.

.7 Equal to Nexans Canada "Firex II" TECK 90 cable in accordance with requirements of CSA C22.2 No. 131, Type TECK 90 Cable, consisting of single or multiple copper conductors with X-link polyethylene insulation enclosed in a liquid and vapour-tight solid corrugated aluminium sheath and, where required, an overall PVC jacket.

.2 Low Voltage (24 Volt) Conductors

.1 "T-90", "R-90" or "RW90" stranded copper conductors as specified above.

.2 Equal to Nexans Canada "Securex II" FAS/LVT/FT1300 volt wire to CSA C22.2 No. 208, Fire /Alarm and Signal Wire, 105° C (220° F) rated, consisting of solid copper conductors (stranded for control wiring), flame retardant PVC insulation, an aluminium/Mylar optional shield with a #22 AWG tinned copper insulation and a drain wire, and, if required for the application, interlocking aluminium armour with or without an overall jacket.

.3 Communications Cable:

.1 All cabling used for Ethernet, Telephone, or other IP-based systems shall follow cabling requirements as outlined in 27 10 00 Structured Cabling.

.3 Connectors

.1 Conductors in Conduit: Except as noted, CSA certified flame resistant thermoplastic, colour coded twist type connectors to suit the system voltage and wire gauge.

.2 Conductors 3/0 AWG and Larger: Long barrel, double crimp, compression type lug connectors, unless otherwise specified.

.3 Armoured Cable: Except as noted, proper squeeze type connectors and plastic anti-short bushings at terminations in accordance with requirements of CSA C22.2 No. 18.3, Conduit, Tubing and Cable Fittings.

.4 Mineral Insulated Conductors: Connector and termination hardware supplied by the cable manufacturer to suit the application.

.5 Corflex/Teck Cable: Connector and termination hardware supplied by the cable manufacturer to suit the application.

.4 Conductor Pulling Lubricant

.1 Equal to Ideal Industries “Yellow 77” or “ClearGlide”, as required.

3 EXECUTION

3.1 INSTALLATION

.1 Conform to the following conductor installation requirements:

.1 Conductor Routing: Conductor routing indicated on the drawings is schematic and approximate. Determine exact routing and conductor lengths at the site. Route conductors to avoid interference with other work. Unless otherwise specified or shown install conductors parallel to building lines.

.2 Conductor Pulling: When pulling conductors into conduit or duct use lubricant and ensure that the conductors are kept straight and are not twisted

.3 Securing/Supporting Conductors: Conform to the following requirements:

.1 neatly secure exposed conductors in equipment enclosures with proper supports and/or ties

.2 support flexible armoured cable in ceiling spaces and stud walls with steel two hole cable straps to Code requirements

.4 Conductor Splicing: Generally, conductor splicing is not permitted unless otherwise approved by the Consultant, and if approved splicing is subject to the following conditions:

.1 splicing is permitted to extend existing conductors

.2 for thermoplastic insulated conductors, splices are to be made within an approved electrical box with mechanical compression connectors to suit the type and size of conductors, and the box(es) are to be properly identified and locations are to be indicated on “as-built” drawings.

.3 where multiple conductors are spliced:

.1 use properly sized Wing Nut connectors, or approved equal, for up to two 8 AWG or three 10 AWG conductors

.2 use pressure type sleeve cable connectors, splices, tee's, etc. for all larger size connections and terminations

.4 insulate all bare surfaces of splices with Scotch No. 33 tape, heat shrink sleeving, or equivalent.

.5 conductors connected to ground rods for service or equipment grounding or to building structural or architectural elements to be terminated, connected and spliced using:

.1 a thermoweld process

.2 an approved non-mechanical compression type connectors where serviceable

.6 install service and feeder conductors as continuous lengths without breaks, measured and cut based on field-measured dimensions.

.7 do not splice mineral insulated “MI” cable

.8 do not splice “Corflex” cable unless justified by cable pulling tension calculations and when approved by the Consultant, and, if approved, locate splices where directed by the Consultant

.5 Conductor Termination:

.1 Where a single solid conductor is terminated in a device under one screw or clamping mechanism, no additional terminating hardware is required.

.2 Where multiple or stranded conductors are terminated in a device under one screw or clamping mechanism, self insulated crimpon cable ends or approved equal shall be used up to and including 10 AWG sized conductors. Approved compression lugs shall be used for larger conductor sizes.

.6 Grounding and bonding conductors:

.1 Insulated grounding or bonding conductors shall be the same type as the line conductors.

.2 Each feeder and branch circuit shall be provided with a separate ground conductor sized in accordance with Electrical Code regulations. All 120 V or 347 V (single phase) branch circuits shall be provided with a separate neutral conductor for each circuit.

.2 Installation of distribution and branch circuit conductors

.1 Install all required conductors.

.2 Non-Fire Rated Conductors: Unless otherwise specified herein or on the drawings, non-fired rated conductors are to be used as follows:

.1 service entrance conductors underground inside or outside the building – RWU-90

.2 conductors underground inside or outside the building – RW-90

.3 conductors above ground inside or outside the building, and in non-climate controlled areas – R-90 or RW-90

.4 unless otherwise specified, conductors in accessible ceiling spaces, within stud wall construction, and in furniture systems to luminaries and wiring devices – AC90 flexible armoured cable, maximum 6 m (20 ft) run permitted

.5 for conductors except as specified above or elsewhere in the Specification or on the drawings – T90 Nylon, R-90 or RW90

.3 Fire Rated Conductors: Unless otherwise specified herein or on the drawings, fire rated conductors are to be ULC 2-hour rated bare MI cable, installed for service as follows:

.1 conductors from engine-generator set to transfer switch

.2 power feeders to Firefighter's elevator(s)

.3 power feeders to fire protection pumps

.4 power feeders to emergency lighting panelboards

.5 power feeders to fire alarm panels and transponders

.6 fire alarm system risers and other feeders as shown or specified

.7 any other conductors as specified on the drawings

.4 "MI" Mineral Insulated Conductor Installation Requirements: Generally, install type "MI" mineral insulated conductors in accordance with the manufacturer's instructions and recommendation, including the following:

.1 provide proper clips, wall brackets, and other support hardware either shown or required

.2 terminate the cable using connectors and installation tools supplied by the cable manufacturer

.3 terminate cable immediately after installation to avoid moisture ingress

.4 do not splice "MI" cables

.5 obtain from the manufacturer a letter stating the "MI" cable has been properly installed, tested, and is ready to be energized, and submit the letter and test result sheets to the Consultant

.6 multiple single conductor mineral insulated cables shall be banded together at a maximum of 900 mm (36 in) intervals to form a free air rated feeder

.7 support at a maximum of 1500 mm (60 in) intervals; additional supports may be required to provide a straight and neat installation

.8 where the cable is exposed, locate as inconspicuously as possible, and run parallel to the building lines.

.9 terminate all cables using manufacturer's approved termination kits, tools and accessories and in accordance with manufacturer's instructions.

.10 following installation and termination of cables, test all cables for continuity, short circuits and grounds using a 1000 volt meggar for 15 seconds in the presence of the manufacturer’s authorized representative

.11 use non-ferrous plates to terminate single conductor cable sheaths at panels, switches, etc., for sizes above 2 AWG

.12 cable run underground to be surrounded by 150 mm (6 in) of compacted sand

.5 “Corflex” Cable Installation Requirements: Install “Corflex” cable in accordance with the manufacturer’s instructions, including the following requirements:

.1 support and secure overhead suspended “Corflex” cable on a system of cable tray where indicated

.2 secure individual cables to cable tray, or where shown, directly to building surfaces by means of single screw non-ferrous clamps

.3 ground and bond single conductor cable at both ends where the sheath currents do not affect the cable ampacity

.4 for certain areas, where the sheath currents will reduce the cable ampacity, ground and bond the cable at the supply end and isolate the cable at the load end as recommended by the cable manufacturer, and provide a 3/0 AWG green TW ground conductor for each cable, all as per Section 10 of the Electrical Code

.6 “Teck” Cable Installation Requirements: Install “Teck” cable in accordance with the manufacturer’s instructions, including the following requirements:

.1 support and secure overhead suspended “Teck” cable tray where indicated

.2 secure individual cables to cable tray or, where shown, directly to building surfaces by means of single screw non-ferrous clamps

.3 terminate cable with lugs and termination kits supplied with the cable

.7 Conductor Sizing:

.1 In residential suites, do not use conductors smaller than 14 AWG in systems over 30 volts.

.2 In areas other than residential suites, do not use conductors smaller than 12 AWG in systems over 30 volts.

.3 conductor sizes indicated on the drawings are minimum sizes and must be increased, where required, to suit length of run and voltage drop in accordance with the voltage drop schedule found at the end of this Section.

.4 all branch circuit wire feeding a 20 A protected lighting circuit to be minimum 12 AWG wire.

.5 all branch circuit wiring feeding a 15 A protected circuit which is over 45 m (150 ft) in length to be minimum 10 AWG wire.

.6 do not use conductors smaller than 8 AWG for exterior luminaire wiring.

.3 Voltage Drop:

.1 Voltage drop in power and control conductors shall be in accordance with the requirements of the Electrical Code. Size conductors, splicing kits, and termination lugs accordingly when sizes are not identified.

.2 Maximum branch wiring distance from panel to load in metres for 120 V single-phase system at 2% voltage drop based on indicated wire size:

Breaker Size (A)	15	20	30	40	50
Max load at 80% (A)	12	16	24	32	40
12 AWG	16.8	12.2	----------	----------	----------
10 AWG	25.9	19.0	----------	----------	----------
8 AWG	39.6	30.4	12.9	----------	----------
6 AWG	62.4	47.2	32.0	23.6	19.0
4 AWG	99.0	73.1	50.2	38.1	30.4
2 AWG	----------	114.3	77.2	57.9	47.2
1 AWG	----------	----------	96.0	73.1	57.9
1/0 AWG	----------	----------	----------	85.3	68.5
2//0 AWG	----------	----------	----------	102.8	80.7
3/0 AWG	----------	----------	----------	----------	95.2

.3 Maximum branch wiring distance from panel to load in metres for 120 V single-phase system at 3% voltage drop based on indicated wire size:

Breaker Size (A)	15	20	30	40	50
Max load at 80% (A)	12	16	24	32	40
12 AWG	24.4	18.3	----------	----------	----------
10 AWG	38.1	29.0	19.1	----------	----------
8 AWG	59.4	44.2	30.5	22.9	----------
6 AWG	91.4	70.1	47.2	35.1	28.2
4 AWG	----------	109.7	73.2	54.9	42.7
2 AWG	----------	----------	114.3	85.3	68.6
1 AWG	----------	----------	----------	103.6	85.3
1/0 AWG	----------	----------	----------	128.0	102.9
2//0 AWG	----------	----------	----------	----------	122.9

3.2 SITE QUALITY CONTROL

.1 Site Tests and Inspections:

.1 Conduct field inspection and testing as specified in Division 01

.1 Feeders and branch circuits rated 100 amperes or greater shall be checked with a 1000 V Meggar for 15 seconds before energization.

.2 Non-Conforming Work:

.1 Defective materials or quality of work, whenever found, at any time prior to acceptance of the work, shall be rejected regardless of previous inspection. Inspection will not relieve responsibility, but is a precaution against oversight or errors.

.2 Replace damaged work which cannot be satisfactorily repaired, restored or cleaned, to the satisfaction of the Consultant at no additional cost to the Owner.

END OF SECTION

1 GENERAL

1.1 INSTRUCTIONS

.1 Comply with the General Conditions of the Contract, the Supplementary Conditions, Division 01 – General Requirements, and Section 26 05 00 – Common Work Results for Electrical.

1.2 SUMMARY

.1 Section includes: Provide raceway and boxes for electrical systems, including but not limited to the following:

.1 Electrical conduit system throughout the project unless indicated otherwise. The conduit systems shall consist of all the necessary conduit, fittings, fastenings, boxes, special supports, etc.

1.3 REFERENCES

.1 Abbreviations and Acronyms:

.1 EMT: Electrical Metallic Tubing

.2 FRE: Fibreglass Reinforced Epoxy

.3 PVC Polyvinyl Chloride

.2 Definitions:

.1 Conduit - The definitions of "Conduit" (Rigid Metal, Rigid PVC, Rigid FRE, Flexible, and Electrometallic Tubing) as defined in the Electrical Safety Code. Other definitions shall be as follows.

.2 Slabbed Conduit - Conduit which is installed within a monolithic concrete floor slab. No slabbed conduit shall be allowed to be installed for this project - use underground conduit where approved.

.3 Underground Conduit - Conduit or duct which is installed below the finished earth grades or below the lower edge of an on grade or subgrade floor slab.

2 PRODUCTS

2.1 MATERIALS

.1 Conduit, Connectors and Fittings:

.1 Use conduit, connectors, and fittings as standard in the trade, unless noted herein or on the drawings to be of a specific type, manufacturer, trade name, series or catalogue number.

.2 Galvanized Rigid Metal Conduit (GRC):

.1 All fittings to be threaded type. Supply bushings with insulated plastic lining for all conduit terminations.

.2 Electric Metallic Tubing (EMT):

.3 All fittings to be steel set screw or raintight type. Supply bushings with insulated plastic lining for all conduit terminations.

.3 Flexible Conduit:

.1 All box connections to have either a nylon lined connector or be provided with an insuliner sleeve. Include sealing ring for fully sealed connection for liquid tight type.

.2 Supply metallic liquid tight type for all exposed flexible conduit.

.3 Supply non-metallic type flexible conduit for inside concrete block walls.

.4 Concealed flexible conduit to be approved galvanized steel or aluminum (where approved) interlocking type, minimum size 12 mm (1/2 in).

.4 Rigid PVC:

.1 Use approved rigid PVC fittings with solvent cement connections for all joints.

.5 Outlet Boxes:

.1 Use outlet boxes, junction boxes, etc. of the types approved for the application. Use the following types for the noted applications:

.1 Recessed boxes in concrete or masonry - Type MBD or MBS boxes.

.2 Surface mounted with EMT conduit - Type 1110 or 2020 "Utility" box.

.3 Surface mounted with rigid conduit - Type FS or FD boxes.

.6 Miscellaneous:

.1 Rigid Metal Expansion Joint - Crouse Hinds "XJ" series with bonding strap or equivalent.

.2 Rigid PVC Expansion Joint - Scepter "O" Ring expansion joint "EJ" series or expansion coupler "EC" series, to suit expected length of movement.

3 EXECUTION

3.1 INSTALLATION / APPLICATION

.1 Application

.1 Galvanized Rigid Metal Conduit (GRC):

.1 Raceway sizes larger than 103 mm (4 in) diameter above grade.

.2 Where installed as an exterior branch circuit above finished grade.

.3 In hazardous locations (complete with sealing type fittings) as classified by the Electrical Code or the Electrical Authority.

.2 Electric Metallic Tubing (EMT):

.1 Conduit sizes 103 mm (4 in) and less, where not specified or required to be otherwise due to special applications or conditions.

.2 To carry branch circuit wiring from local distribution or lighting panels to area circuit junction boxes above ceiling systems.

.3 Flexible conduit:

.1 As branch circuit wiring from area circuit junction boxes above ceiling systems to light fixtures and from outlet boxes to suspended fixtures.

.2 Restrict flexible conduit to less than 3600 mm (12 ft) in length. Suitably clip and support every 900 mm (3 ft) in length the flexible conduit used above ceiling systems.

.3 As a raceway in stud walls or partitions.

.4 Do not use flexible conduit where conduit is run exposed.

.4 Liquid tight flexible conduit:

.1 As the raceway between the distribution conduit and equipment terminal boxes of vibrating and rotating equipment.

.2 Restrict length to be less than 600 mm (24 in).

.5 Rigid PVC or Rigid FRE conduit

.1 As an underground raceway for building services or as a slabbed conduit where approved.

.6 Rigid PVC conduit

.1 As underground raceways for branch circuit wiring to exterior connections.

.7 Rigid PVC duct (DBII)

.1 Use in sizes 50 mm (2 in) and larger where encased in concrete or direct buried for underground communication utilities services.

.8 Use corrosion resistant conduit where indicated on the drawings.

.9 Do not use aluminum conduit on this project.

.2 Installation

.1 Where more than one type of product or method of installation could apply, the most restrictive products and methods of installation shall take precedence.

.2 All conduit connections to be as tight as possible. Failure to tighten any conduit connections in block, tile or concrete elements will result in the element being removed and reinstalled at this Section's expense.

.3 Do not use the conduit system as the ground path for the building wiring system. Supply all wiring systems with a separate copper ground conductor sized accordingly to ensure ground path continuity.

.4 Conceal conduit in all finished wall areas but may be run exposed in service and equipment rooms.

.5 Where conduit is run exposed, run parallel to the building lines. Supply grouped concentric bends where two or more conduits are installed.

.6 Do not install conduit horizontally in masonry walls.

.7 Lay out all conduits and install to avoid the proximity of heating pipes and ducts. Do not run conduit within 900 mm (3 ft) of such pipes and ducts.

.8 Plug conduit ends during construction with plastic push pennies. Cap conduits stubbed for future use with conduit caps and seal, if below grade.

.9 Rigidly and securely support conduit systems with conduit straps to the building structure. Support multiple conduit runs, if not easily attached to the building structure directly, by Unistrut hanger assemblies. Bailing wire or flexible metal strapping will not be accepted.

.10 Concrete encased underground conduits shall be enclosed within a minimum 100 mm (4 in) monolithic poured concrete envelope.

.11 Install underground conduits that are below a building floor slab at a minimum depth of 460 mm (18 in) below the finished surface.

.12 Coordinate all underground conduit routes with other Sections to prevent interference. Install sleeves for all underground conduits passing through structural or foundation elements.

.13 Extend conduits stubbed through equipment bases a minimum of 38 mm (1½ in) above the base.

.14 Install two 32 mm (1¼ in) spare empty conduits stubbed into the ceiling space from the top of all recessed panelboards. Terminate in suitable junction box with blank cover labelled accordingly.

.15 Install a nylon pull cord in all empty conduits. Adhere tags at both ends indicating system and destination. Maintain a pull cord in systems conduits used only to partial capacity.

.16 Colour code all conduit systems throughout the building during installation with a patch of paint at all junction and pull boxes and points of concealment as follows:

.1 Black – Power Distribution (also indicate specific source/panel)

.1 Black/Green – 600/347 V Normal

.2 Black/Blue – 208/120 V Normal

.2 Red – Fire Alarm System (also indicate circuits)

.3 Orange – Emergency/Standby Power System (also indicate specific source/panel)

.1 Orange/Green – 600/347 V Emergency/Standby

.2 Orange/Blue – 208/120 V Emergency/Standby

.3 Orange/Purple – Uninterruptible Power

.4 Yellow – Public Address/Intercom/Audio-Visual Systems

.5 Green – Security System

.6 Purple - Controls

.7 Blue – Telecommunications System

.3 Underground Conduit:

.1 Install a copper ground conductor in all underground conduit.

.2 Connect underground conduit to rigid metal conduit elbows or be concrete encased at all points where a three-phase feeder or communications conduit comes through a floor slab, enters a building, or comes to the surface.

.3 Protect Rigid PVC conduit with steel sleeves or box out sections where they pass through foundation walls or footings.

.1 Do not use steel conduit or sleeves where single-phase cables are run separately.

.4 Drill and drain in a gravel sump at the low point of the run all underground ductbank runs. Slope away from the building all underground conduits with the low point outside of the building walls. It is preferred to have the low point occur at the furthest point from the building.

.5 Appropriately seal all underground conduit runs which enter walls below grade level at the exterior wall. Install conduits with an exterior water stop where they pass through an exterior building wall below grade.

.4 Rigid PVC Conduit:

.1 Bend on site using a non-flame type heat source to accommodate the required contours.

.2 Use conduit fittings, couplings, etc. that are watertight type, fastened with an approved cement.

.3 Do not penetrate fire rated walls, floors, or ceilings.

.5 Partition Walls:

.1 Feed all conduit in demountable, prefabricated or standard stud partition walls into the wall from the ceiling. Make no connections from the floor or walls unless shown on drawings. Terminate conduit in a junction box in the ceiling space within 900 mm (3 ft) of the ceiling system penetration point.

.2 Restrict flexible conduit in demountable or prefabricated partitions to a maximum 25 mm (1 in) size.

.6 Outlet Boxes:

.1 The location of outlets, fixtures, panels, etc., as shown on the drawings, are approximately correct, but the Consultant reserves the right to alter the location of any number of them up to 3000 mm (10 ft) without incurring extra cost, if altered before installation is commenced on any individual item.

.2 In general, Use 100 mm (4 in) octagon boxes for light fixture outlets.

.3 In concrete slabs or walls, use boxes greater than 50 mm (2 in) deep.

.4 In general, in fire rated partitions, install outlet boxes with openings no larger than 160 cm^2 (25 in^2) in area. Install outlet boxes on opposite side or same side of a fire rated partition offset at least one stud space to maintain the integrity of the fire separation.

.1 Refer to code plans indicating fire rated partitions

.2 Where openings exceed this criteria, install intumescent material that comply with ULC fire rated assemblies.

.5 Use watertight with screw fittings and watertight gaskets to install outlet boxes outside of the building.

.6 In general, install outlet boxes of adequate size and required dimensions for all outlet and conduit junctions.

.7 Rigidly secure all outlet boxes in position by approved methods. For those intended for hanging fixtures, supply with fixture studs, self aligning type for sloping ceilings.

.8 Outlet boxes designated for future use, install with blank-metal coverplates. Install coverplates, on outlet boxes designated for other than future wiring devices, in time to be painted over by the painting Section.

.9 Place all pull boxes and terminal boxes in inconspicuous but accessible locations.

.10 Centre all outlets, panelboards, lighting control, panels and equipment on construction panels, wood paneling or boarding, ceiling tile, etc.

.11 Install components or devices such as lighting controls and receptacles or thermostats, etc., which occur one above the other in the same general location, in the same vertical line.

.12 Install adjacent items such as panels and fire hose cabinets, etc., with the tops of their trims in line.

.13 Locate clocks, bells, horns, speakers, etc. as shown or specified. However, mount these items symmetrically in paneling or tiles, and bear proper relationship to doors, ventilation grilles, etc. Where specific heights are not covered, discuss the relation with, and approved by, the Consultant.

.14 In no case shall luminaires, pipes, ducts or other elements be allowed to obstruct clocks, grilles, exit lights, etc.

.15 Mount recessed or surface ceiling mounted components to replace full tiles where possible or be centred on the tile or grid intersections.

.16 Locate lighting controls on the latch side of door or primary leaf within 150 mm (6 in) of the jamb or sidelight. Where light controls are shown on hinge side of single doors, in cases where glazing makes placing the controls on the latch side not possible, ensure that lighting controls are within 150 mm (6 in) beyond door in fully open position and no part extends behind the open door. Verify door swings and primary leaves on double doors before proceeding with installation of the control box and associated conduit/wiring.

.17 Ensure all outlet boxes are installed with vapour barrier protection integral with specific wall or ceiling construction. For each outlet box installed which pierces a vapour barrier, supply an appropriately sized vapour barrier box surrounding outlet box to seal all air leaks and maintain vapour barrier continuity.

.18 In finished areas of the building, conceal as much conduit/wiring as possible. Where in this Section's opinion it is necessary or advantageous to run wiring on the surface, obtain approval from the Consultant before proceeding. Install all surface raceways as metal and manufactured by Wiremold unless otherwise indicated. Install surface raceways at size to suit conductors being carried. Use only approved components, fittings, and methods of securing, joining and supporting surface raceways and outlet boxes. Where surface mount raceways and outlet boxes are used, paint to match the specific wall or ceiling finish by the painting Section.

.7 Mounting Height:

.1 Where receptacles or other devices interfere with heating equipment, mount horizontally in the toespace below the heating unit unless otherwise noted.

.2 For mounting heights of the various system devices not indicated herein refer to the specific system Section or drawing detail.

.3 Verify mounting heights of outlet boxes in special or decorative wall systems prior to rough-in.

.4 For exact mounting heights and requirements of outlets and devices built into millwork or architectural furnishings, refer to elevations and details shown on the architectural drawings. Verify with millwork Section prior to rough-in.

.8 Conduit Seals:

.1 In areas where conduits pass through walls or other building surfaces in which different temperatures exist (i.e. refrigerated spaces or exterior walls and insulated ceilings or roofs, etc.), seal off the conduits with appropriate materials and methods to prevent breathing and subsequent condensation. Complete the sealing such that moisture is not trapped at the seal.

END OF SECTION

1 GENERAL

1.1 INSTRUCTIONS

.1 Comply with the General Conditions of the Contract, the Supplementary Conditions and the General Requirements of Division 01 (and Division 20 or 26).

1.2 SUMMARY

.1 Section includes: Provide identification for electrical systems, including but not limited to the following:

.1 Identification nameplates for all electrical apparatus; i.e. panels, motor starters, switchgear, transformers, disconnect switches, breakers, contactors, system control panels, telephone panels, etc.

.2 Directory cards for all panelboards; i.e. power, lighting, low voltage systems, communications, etc. All power and systems wiring shall be colour coded in accordance with this Section and be provided with appropriate wire markers identifying panel circuits.

2 PRODUCTS

2.1 MATERIALS

.1 Lamicoid Nameplates:

.1 All identification nameplates and nametags unless otherwise specified shall be engraved white letters on black lamicoid stock with bevelled edges. The lamicoid stock shall be 1.5 mm (1/16") minimum thickness.

.2 The nameplates shall be engraved with the following information:

.3 Nameplates for panel and cabinet identification shall typically include the following:

.1	LP-"A"	13 mm (1/2") high lettering
.2	120/208 VOLT	8 mm (5/16") high lettering
.3	FED FROM "MCC-1"	8 mm (5/16") high lettering

.4 All other electrical equipment shall be typically identified as follows:

.1	SUPPLY FAN "SF-1"	8 mm (5/16") high lettering
.2	208 VOLT - 3 PHASE	8 mm (5/16") high lettering
.3	FED FROM "MCC-1"	8 mm (5/16") high lettering

.5 The final wording of all nameplates shall be reviewed and approved by the Owner and Consultant prior to fabrication.

.2 Panel Directories

.1 Each panel circuit directory card shall have clearly typed information as with the following example:

.1 PANEL NAME . . . . . LP-"A"

.2 PANEL VOLTAGE . . . . . 120/208 VOLT

.3 PANEL SUPPLY . . . . . 150 AMP

Circuit Number	Load	Room No. or Locations
1	lighting	143
2	Receptacles	029
2	Supply fan SF-4	Roof

.2 All systems distribution cabinets shall be complete with a directory card showing circuit numbers, room locations, and a blank column for "REMARKS".

.3 Wire and Cable Colour Coding

.1 All power and systems wiring shall be colour coded as follows:

.1 Power	- Phase A	- Red
	- Phase B	- Black
	- Phase C	- Blue
	- Neutral	- White
	- Ground	- Bare or Green
.2 Motor Control		- Yellow

.2 Provide suitable clip-on or stick-on wire markers for all wires at points of termination and interconnection. Wire markers shall identify panel and circuit number in a clear and logical manner.

3 EXECUTION

3.1 INSTALLATION

.1 Lamicoid nameplates shall be mounted behind the panel door, fastened with contact cement.

.2 Temporary panel directory cards shall be provided and filled in as the circuits are installed. The temporary directory card shall be replaced with a typed permanent directory at job completion.

.3 The panel directory card shall be inserted in the card holder on the inside of the panel door and be protected by a clear plastic sheet.

.4 Feeder cables shall be colour coded in each terminal panel and junction box with a minimum 75 mm (3") taped band.

.5 All power and systems junction and terminal box covers shall be marked with permanent black marker as to system installed (i.e. "F.A." for Fire Alarm) and other details such as circuit numbers, detection zone, etc. Exposed boxes shall have marking on inside face of cover.

END OF SECTION

1 GENERAL

1.1 INSTRUCTIONS

.1 Comply with the General Conditions of the Contract, the Supplementary Conditions, Division 01 – General Requirements, and Section 26 05 00 – Common Work Results for Electrical.

1.2 SUMMARY

.1 Section includes: Provide electrical work commissioning.

1.3 REFERENCES

.1 Definitions:

.1 Commissioning: the process of demonstrating to the Owner and Consultant, for the purpose of final acceptance, by means of successful and documented functional performance testing, that all systems and/or subsystems are capable of being operated and maintained to perform in accordance with requirements of the Contract Documents, all as further described below

.2 Commissioning Agent: the commissioning authority who will supervise the commissioning process, and who will recommend final acceptance of the commissioned electrical work

.3 Start-Up and Adjusting: the process of equipment manufacturer's/supplier's technical personnel, with the Contractor, starting and operating equipment and systems, making any required adjustments, documenting the process, and submitting manufacturer's/supplier's start-up reports to confirm that the equipment has been properly installed and is operational as intended, and a pre-requisite to operational performance testing

.4 Operational Performance Testing: testing, adjusting and operating of components, equipment, systems and/or subsystems, by the Contractor, after start-up but before functional performance testing, to confirm that all components, equipment, systems and/or subsystems operate in accordance with requirements of the Contract Documents, including all modes and sequences of control and monitoring, interlocks, and responses to emergency conditions, and including submittal of pre-functional performance testing documentation sheets

.5 Functional Performance Testing: a repeat of successful operational performance testing by the Contractor, in the presence of the Commissioning Agent and Consultant with completed Commissioning Agent's commissioning documentation sheets to document, validate and verify that the equipment, systems and subsystems are complete in all respects, function correctly, and are ready for acceptance

.6 Commissioning Documentation Sheets: prepared sheets for operational performance testing and for functional performance testing supplied by the Commissioning Agent for each piece of equipment/system to be commissioned, each sheet or set of sheets complete with the Project name and number, date of commissioning, equipment/system involved, equipment/system name and model number, equipment tag as per the drawings, and, for each commissioning procedure listed, a column giving the expected data as per the Contract Documents, a column to fill in the observed data during commissioning, and space for signatures of the Contractor and Commissioning Agent

.7 BAS: building automation system

.8 Systems Operating Manual: a manual prepared by the Commissioning Agent to present an overview of the building electrical systems and equipment to be used by building maintenance personnel to assist them in daily operation of the systems

.9 Validate: to confirm by examination and witnessing tests the correctness of equipment and system operation

.2 Reference Standards: Versions of the following standards current as of the date of issue of the project apply to the Work of this Section. Where regulatory requirements use older version of a standard, comply with the version year adopted by the Authority Having Jurisdiction

.3 Commissioning work is to be in accordance with requirements of the following:

.1 CSA Standard Z320, Building commissioning

1.4 SUBMITTALS

.1 Submittals under this Section shall be in accordance with Division 01.

.2 Product Data and Shop Drawings:

.1 Submit to the Commissioning Agent, at the same time as submittal to the Consultant, 1 copy of each shop drawing or product data sheet associated with equipment or systems to be commissioned.

.3 Commissioning Plan, Procedures, Schedule and Data Sheets:

.1 Submit for review, a Commissioning Plan with schedule, commissioning procedures for all commissioning events, and a copy of the Commissioning Agent’s commissioning data sheets for all equipment/systems to be commissioned.

.4 List of Commissioning Instruments:

.1 Submit a list of commissioning instruments and for each instrument, indicate the purpose of the instrument and include a recent calibration certificate.

.5 Start-Up and Test Report Sheets:

.1 Submit equipment and system manufacturer's start-up and test report sheets for review a minimum of 1 month prior to equipment and system start-up procedures.

.6 Letters To Certify Readiness for Functional Performance Testing:

.1 After start-up and successful pre-functional performance testing and submittal of completed forms, submit, for each system or subsystem, a letter to confirm that pre-functional performance testing has been successfully completed and the system or subsystem is ready for functional performance testing and the commissioning process to commence.

1.5 ADMINISTRATIVE REQUIREMENTS

.1 Objectives of the commissioning process are as follows:

.1 to support quality management by means of monitoring and checking the installation

.2 to verify equipment/system performance by means of commissioning of the completed installation

.3 to move the completed equipment/systems from the "static completion" state to the "dynamic" operating state so as to transfer a complete and properly operating installation from the Contractor to the Owner

1.6 QUALITY ASSURANCE

.1 Licenced Professionals:

.1 Retain the services of a qualified Commissioning Agent.

.1 be a member of the Professional Engineers Association in the Province of the work

.2 be a member of the Building Commissioning Association, and a Certified Commissioning Professional (CCP) as designated by the Building Commissioning Association

.3 have a minimum of 5 years of successful documented commissioning experience on projects of similar size and complexity as this Project

.4 supply a qualified P. Eng. and a Building Commissioning Association Certified Commissioning Professional (CCP) or an ASHRAE Commissioning Project Management Professional (CPMP) on site to supervise the commissioning process

2 PRODUCTS

2.1 NOT APPLICABLE

3 EXECUTION

3.1 SITE QUALITY CONTROL

.1 Commissioning

.1 Commission the electrical work in accordance with requirements of this Section of the Specification.

.2 Prerequisites to Commissioning: Prerequisites to successful completion of commissioning are as follows:

.1 Submittal of signed start-up and test reports.

.2 Completion by the Contractor of system testing reports as per the Electrical Work Testing Section.

.3 Successful completion and documentation of operational performance testing.

.4 Submittal of letters to the Consultant certifying that the systems and subsystems have been started, tested, adjusted, successfully operationally performance tested, are ready for functional performance testing, and are in accordance with requirements of the Contract Documents.

.2 Phasing Of Commissioning

.1 If the project will be constructed in phases as described in the Specification, commissioning must be phased to suit the progress and phases of the work.

.3 Deficiencies Listed During Commissioning

.1 Deficiencies listed by the Consultant and Commissioning Agent during the commissioning process are to be corrected by the Contractor within 10 calendar days unless agreed otherwise with the Consultant, and when deficiencies have been corrected, notify the Consultant and Commissioning Agent at once.

.4 Systems To Be Commissioned

.1 Electrical systems to be commissioned include, but are not to be limited to, the following:

.1 Electrical distribution systems

.2 Emergency power systems

.3 Communication systems

.4 Lighting control systems

.5 Security Systems

.5 Commissioning Process

.1 The commissioning process is to be performed in stages and is to include, but not be limited to, the following:

.1 Stage 1: Commissioning of electrical equipment/systems as listed in this Section, which is a prerequisite to an application for Substantial Performance and includes supervising and validating results of functional performance testing, and submittal of the reviewed Systems Operating Manual.

.2 Stage 2: Commissioning work to be performed 12 months after issue of a Certificate of Substantial Performance and which includes supervision of the Contractor's "fine tuning" of equipment/systems.

.3 Stage 3: Successful completion of satisfactory equipment/system operation during the first month after issue of a Certificate of Total Performance of the Work.

.4 Stage 4: Successful completion of satisfactory equipment/system operation during the 3rd month after issue of a Certificate of Total Performance of the Work.

.6 Responsibilities of the Commissioning Agent

.1 Construction Phase: During the construction phase the Commissioning Agent is to:

.1 Review the Contractor's shop drawings for commissioning related issues, and report any such issues to the Consultant.

.2 As soon as possible after project start-up, prepare and issue a Commissioning Plan based on the Contractor's construction schedule.

.3 Prior to tests, supply and issue operational performance test commissioning data sheets for all equipment and systems to be commissioned.

.4 Monitor and inspect the installation on a regular basis throughout the construction stages, issue reports identifying any issues which may have an impact on the commissioning process, and work with the project team to expeditiously resolve any problems that may arise due to site conditions.

.5 Arrange with the Contractor for on-site commissioning meetings on an as-required basis, to be attended by the Contractor and applicable subcontractors, the Owner, and the Consultant, chair the meetings, and prepare and distribute meeting minutes to all attendees.

.6 Witness and validate tests, identify deficiencies, and issue progress reports.

.7 Coordinate commissioning scheduling with the Contractor.

.8 Review operational performance test commissioning data sheets submitted by the Contractor, then witness and supervise functional performance testing and supervise and direct the commissioning process, validate the commissioning procedures, witness completion of commissioning data sheets by the Contractor, and sign the completed data sheets.

.9 Perform a preliminary review of the Contractor's O & M Manuals, before they are issued to the Consultant, and issue any comments to the Consultant.

.10 Coordinate with the Contractor and Owner the training and instructions by the Contractor and his equipment and system manufacturers/suppliers to the Owner's operating and maintenance personnel, and comment on the quality of the training and instructions to the Consultant.

.11 Prepare and issue to the Owner prior to equipment and system training by the Contractor, the Systems Operation Manual.

.2 Post Construction Phase: During the post construction phase the Commissioning Agent is to:

.1 Prepare and issue the final report on commissioning, identifying any deficiencies that remain outstanding.

.2 Recommend any training and/or instructions to be given to the Owner's operating and maintenance personnel in addition to training and instructions already given.

.3 After Substantial Performance, witness system checks and validate documentation by the Contractor as follows:

.1 Once during the 1st month of building operation.

.2 Once during the 3rd month of building operation.

.3 Once between the 4th and 10th month of building operation but during a season opposite to the 1st or 3rd month visits.

.4 Ensure that any deficient work resulting from system checks described above are corrected.

.5 3 months after Substantial Performance, attend a question and answer session(s) with the Contractor to answer any questions and concerns related to commissioning work from the Owner's operating personnel.

.7 Responsibilities of the Consultant

.1 Construction Phase: Responsibilities of the Consultant are as follows:

.1 Review the Contractor's shop drawing/product data submissions for general conformance requirements of the Contract, and add any review comments made by the Commissioning Agent as applicable.

.2 Review the Contractor's delivery schedule and installation program to ensure that the installation sequences have been coordinated with the construction schedule.

.3 Monitor and inspect the electrical work throughout the construction stages to ensure that the work is in accordance with requirements of the Contract, witness tests, note deficient work, and ensure that deficient work is corrected.

.4 Attend site commissioning meetings requested by the Commissioning Agent and arranged by the Contractor.

.5 When informed by the Contractor that work is essentially complete, inspect the equipment and systems, issue deficiency reports, and ensure that deficiencies are corrected in a timely manner.

.6 With the Commissioning Agent, review the Commissioning Plan to ensure that proposed tests and the sequencing and methods of tests conform to Contract requirements, and that the testing and commissioning sequences coincide with the construction schedule.

.7 With the Commissioning Agent, certify completion of the commissioning.

.8 Responsibilities of the Contractor

.1 Construction Phase: Responsibilities of the Contractor during the construction phase are as follows:

.1 Prepare and submit an installation schedule which is to include the time schedule for each activity with lead and lag time allowed and indicated, shop drawing/product data and working detail drawing submissions, and major equipment factory testing and delivery dates.

.2 Prepare and submit a commissioning schedule which is to include a time schedule coordinated with the installation schedule referred to above, and allowances for additional time for re-tests as may be required and update the schedule on a monthly basis as required.

.3 When requested by the Commissioning Agent, arrange site commissioning meetings with the Owner, Consultant, and applicable subcontractors present, to be chaired by the Commissioning Agent who will also prepare and distribute meeting minutes.

.4 Promptly correct all reported deficient work, and report when corrective work is complete.

.5 Where required by Codes and/or the Specification, retain equipment manufacturers/suppliers or independent third parties to certify correct installation of equipment/systems.

.6 Under the supervision of equipment manufacturers/suppliers, start-up and adjust all equipment to design requirements, and submit start-up sheets which include all equipment data such as manufacturer and model number, serial number where applicable, and performance parameters, all signed by the equipment manufacturer/supplier and the Contractor.

.7 In accordance with the updated commissioning schedule and actual progress at the site, certify in writing to the Consultant and the Commissioning Agent that equipment and/or systems are complete, have been checked, started and adjusted, successfully operationally performance tested and documented, and are ready for functional performance testing and the commissioning procedures, giving the Consultant and Commissioning Agent a minimum of 5 working days notice.

.8 Perform system and subsystem functional performance testing in the presence of the Commissioning Agent and under the supervision of the Commissioning Agent, and submit to the Consultant and Commissioning Agent, completed and signed functional performance testing and commissioning data sheets (issued by the Commissioning Agent) and also signed by the Commissioning Agent.

.2 Post Construction Phase: Responsibilities of the Contractor during the post construction phase are as follows:

.1 Optimize system operation in accordance with the building’s occupant’s needs and comments using the System Operation Manual prepared by the Commissioning Agent as reference.

.2 Complete all commissioning procedures, activities, and performance verification procedures that were delayed or not concluded during the construction phase.

.3 Accompanied by the Commissioning Agent, complete system checks and "fine tuning" with signed documentation as follows:

.1 Once during the 1st month of building operation.

.2 Once during the 3rd month of building operation.

.3 Once between the 4th and 10th months in a season opposite to the 1st and 3rd month visits.

.4 Correct all deficiencies revealed by the system checks described above, and, where required, involve equipment manufacturer’s/supplier’s during corrective actions, and report completion of corrective work.

.5 Schedule for 3 months after Substantial Performance and conduct question and answer session(s) at the building with the Owner's operating and maintenance personnel, with the duration of the session(s) dictated by the number of questions and concerns that have to be addressed.

END OF SECTION

1 GENERAL

1.1 INSTRUCTIONS

.1 Comply with the General Conditions of the Contract, the Supplementary Conditions, Division 01 – General Requirements, and Section 26 05 00 – Common Work Results for Electrical.

1.2 SUMMARY

.1 Work to include all labour, materials, tools, appliances, control hardware, sensors, wiring, junction boxes and equipment necessary for and incidental to the delivery, installation and furnishing of a completely operational standalone lighting control system, as described herein.

.2 All lighting controls shall meet or exceed all locally-enforced energy codes including all mandatory control requirements for Ontario Building Code.

.3 All spaces shown within the building and all exterior lighting shall be controlled using the installed lighting control system.

.4 Examine all general specification provisions and drawings for related electrical work required as work under this section.

.5 Coordinate all work described in this section with all other applicable plans and specifications, including but not limited to wiring, conduit, fixtures, HVAC systems and building management systems.

.6 All lighting control is subject to functional testing. Lighting control devices and control system shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with this section and the manufacturer’s installation instructions.

1.3 REFERENCES

.1 Division 25 Integrated Automation

.2 Section 26 05 00 Common Work Results for Electrical

.3 Section 26 50 00 Lighting

.4 Section 26 52 00 Emergency Lighting

.5 Ontario Building Code

1.4 DEFINITIONS

.1 A Passive Infrared sensor (PIR sensor) is an electronic device that measures infrared (IR) light radiating from objects in its field of view.

.2 An Ultrasonic sensor work on a principle similar to radar or sonar which evaluate attributes of a target by interpreting the echoes from radio or sound waves respectively. Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor.

.3 A Microphonic sensor is a microphone that picks up ambient sounds and detects sounds that are typical for human occupancy. Unlike ultrasonic, no sound is transmitted from the unit and is therefore a passive technology. Unit will not record sounds or have any method to transmit sounds to any other device. Microphonic sensor may be used in locations where ultrasonic sensors are specified herein.

.4 Dual Technology sensors combine both passive infrared and ultrasonic/microphonic technologies into one sensor.

.5 A Photosensor is an electronic device that detects the prevailing light level and sends the information either as an analog or a stepped digital output as a relative representation of the light level.

1.5 QUALITY ASSURANCE

.1 All sensors, accessories and components must have a recognized certification mark (such as CSA or ULC) or a recognized field evaluation mark (such as CSA or ESA) as designated by the Ontario Electrical Safety Code.

.2 All components (and associated re-installation) shall be warrantied against defective manufacturing and installation for minimum of 2 (two) years from substantial completion.

1.6 SUBMITTALS

.1 Complete sets of shop drawings shall be submitted indicating the following:

.1 Product component cut sheets.

.2 Wiring/Wireless schematics for typical and standalone room types in this project. (i.e. classroom, private office, lobby, open office, boardroom, etc.).

.3 Functional testing sheets with room-by-room requirements table.

2 PRODUCTS

2.1 APPROVED MANUFACTURERS

.1 Acceptable manufacturers are:

.1 Sensor Switch/Accuity

.2 Lutron

.3 WattStopper/Legrand

.4 Leviton

.5 Cooper

.6 Phillips

.2 If any manufacturer requires additional components, wiring, space requirements, structural, etc. over that of the indicated manufacturer in these specifications; then those items and costs shall be included. Any additional installation requirements shall employ the trades and consultants already on site to provide a complete and working lighting control system and paid for by the manufacturer.

2.2 OCCUPANCY SENSORS

.1 Wall Mount Sensors (line voltage)

.1 Dual Technology sensors

.1 For use in small conference room, break room, or similar.
.2 Each room shall be equipped with line voltage, dual relay, wall mounted, dual technology occupancy sensor(s).
.3 Wall sensor shall have features such as large activation buttons, automatic time-delays, automatic sensitivity, and walkthrough modes.
.4 By default, first relay shall be set to automatic on; second relay shall be set to manual on.

.2 Passive Infrared sensors

.1 For use in small utility rooms small service rooms, small storage rooms, or similar.
.2 Each room shall be equipped with line voltage, wall mounted, passive infrared occupancy sensor.
.3 Wall sensor shall have large activation button and be set to manual on.

.3 Ultrasonic sensors

.1 For use in small utility rooms, single washrooms, small multi-stall washrooms, or similar.
.2 Each room shall be equipped with line voltage, wall mounted, ultrasonic occupancy sensor.
.3 Wall sensor shall have large activation button and be set to manual on.

.2 Ceiling / Close-to-Ceiling Mount Sensors (low voltage)

.1 Dual Technology sensors

.1 For use in offices, classrooms, training rooms, or similar.
.2 Each room shall be equipped with low voltage, dual-technology occupancy sensor(s), power/relay module, and digital control switch(es).

.3 All sensors shall work in conjunction with one another through wired or wireless connections.

.2 Ultrasonic sensors

.1 For use in corridors, stairwells, utility rooms, service rooms, small storage rooms, multi-stall washrooms, or similar.
.2 Each room shall be equipped with low voltage, ultrasonic occupancy sensor(s), power/relay module, and digital control switch(es).
.3 All sensors shall work in conjunction with one another through wired or wireless connections.

.3 Exterior sensors

.1 Passive Infrared sensors

.1 For use in parking garages, parking lots, or similar.
.2 Each room/areas shall be equipped with low voltage, passive infrared occupancy sensor(s), and power/relay module.
.3 All sensors shall work in conjunction with one another through wired or wireless connections.

2.3 DAYLIGHTING CONTROL SENSORS

.1 Provide daylighting control to light fixtures within floor areas substantially illuminated by daylight either through toplight or sidelight windows. The fixtures and spaces affected by the toplight or sidelight illumination are indicated on the drawings.

.2 In addition to the occupancy based lighting control within this space, the light fixtures in these areas are required to dim or switched off if exterior sunlight levels increase beyond a programmed threshold. Switched systems shall be used in warehouses, corridors, storage, and regularly unoccupied spaces. In offices, meeting spaces, lobbies and other normally occupied spaces dimming controls shall be used with continuous-type dimming ballasts or drivers.

.3 Lighting control manufacturer/installer shall ensure that ballast and/or drivers used by lighting manufacturer are compatible with lighting control system or shall incur all costs for replacement to a compatible unit at no additional cost to the project.

.4 Provide photosensor capable of multi-zone switching or dimming with a minimum of 3 sensing levels and connect to room controller/relay.

.5 Combination photosensor/occupancy sensors are not recommended and may be used only where placement of device will not degrade performance of either function.

.6 The system shall operate with multiple users in harmony and not react adversely to manual override inputs. Daylight harvesting shall not impede personal lighting control and the ability to adjust light levels on a per fixture basis.

2.4 DIGITAL WALL SWITCHES

.1 Low voltage momentary pushbutton switches in single or multi-button (up to 8 in single gang) configuration. Digital wall switches shall include the following features:

.1 Buttons shall be large enough to have room to be engraved. Manufacturer shall provide engraving service for first set of buttons on each switch.

.2 Dimming switches shall include bi-level LEDs to indicate load levels using multiple steps.

.2 Digital wall switches shall be used when low-voltage power/relay modules are used and shall not be used to replace wall-mounted line voltage occupancy sensor/switches.

2.5 POWER/RELAY MODULES

.1 Power/relay modules shall be standalone or integrated units that shall house one or multiple relays for controlling room or area lighting and shall provide control input from lighting control devices. More than one module may be required in any one area to allow for full control. Multiple modules shall be able to be mesh networked allow communication so that all modules work as one complete system.

.2 Low voltage sensors and digital wall switches shall communicate with power/relay module(s) that will operate lighting within the room being controlled.

.3 Standalone modules without dimming shall have the following properties:

.1 Communications capability with low voltage sensors within the room.

.2 Minimum two relays are required for most spaces.

.4 Standalone modules with dimming shall have the following properties:

.1 Analog (0-10V) or digital (DALI or DMX) control interface to compatible with connecting devices.

.2 Communications capability and compatibility with other low voltage sensors or switches within room.

.5 The module may be incorporated or integrated into a ballast or driver.

.6 Module shall have additional NO/NC contact for connection to local low voltage HVAC control unit. If module does not incorporate, then the manufacturer/installer shall be responsible for an additional external relay to provide this function where required.

.7 Modules shall be interconnected via plenum-rated (FT-6) low-voltage network wiring or via wireless connections.

2.6 LOW VOLTAGE LIGHTING CONTROL PANELS

.1 CSA approved, factory pre-wired, assembled and tested panels for low voltage lighting control.

.2 Components to include but not be limited to following:

.1 PC connectivity, TCP/IP connections, historical and runtime accumulation, graphic programming and control;

.2 interface cards, I/O devices and connecting cables as required;

.3 NEMA 1 enamelled painted steel tub, with hinged, key lockable, surface or flush mounting cover and drip shield (for surface mounted panels);

.4 interiors consisting of motherboard with relay LED status indication, colour coded connections, card slots and barrier to separate voltage levels;

.5 sized suitable for up to forty-eight (48) relays as required;

.6 specification grade, heavy duty, 20 ampere rated plug-in relays complete with auxiliary contacts to provide status indication;

.7 power supplies sized as required;

.8 colour coded and labelled terminals with push-on connections;

.9 panel identification card in plastic pouch affixed inside of cover;

.10 barrier for separation of high voltage (class 1) and low voltage (class 2) wiring;

.11 screwless, removable plug-in connections for low voltage terminations;

.12 DIN rail mounted contactors, NO or NC as required and compatible with and of rating to suit lighting, ballasts and loads being connected and controlled;

.13 power supply as required to supply sufficient power to system components;

.14 master ON/OFF group switching card to sequence any number of relays in a panel ON or OFF without requiring handheld device or special programming tools; pushbutton controls with LED indicators to be provided for group operation and status;

.15 provide individual direct overrides for each relay or per group as zoned on drawings;

.16 group switching card;

.17 interface modules, network clock, photocontrol package as required to provide automatic control, distributed processing and communications with central system control software, other panels and Mechanical Division building automation system;

.18 Switches:

.1 24 V, momentary contact, switches, single, decorative styling, ivory pushbutton type with pilot and location light LEDs;

.2 24 V, momentary contact, switches, multi ivory pushbutton type with pilot and location light LEDs, and removable lens cap for labelling each switch with laminated tape;

.3 24 V, momentary contact, key operated switches complete with keys;

.4 24 V, momentary contact, ivory toggle type switches;

.19 Wall plates:

.1 decorative style, Lexan screwless wall plates;

.2 type 302 stainless steel wall plates, number of gang as required, suitable for switches specified and complete with mounting brackets and matching screws;

.20 wiring in conduit, in accordance with system manufacturer's requirements;

.21 programming and interfacing module cards for integration to BAS to suit required system sequence of operation of lighting circuits;

.22 sequence of operation to suit specific applications as reviewed with Consultant.

.3 Supply with shop drawings, detailed wiring diagrams, and floor plans identifying lighting controls and lighting panels being integrated to and any mechanical systems interconnections.

.4 System panels to be sized to accommodate 10% future components.

2.7 RECEPTACLE CONTROL

.1 Receptacle control shall be used in all offices and computer classrooms as minimum requirement as per ASHRAE 90.1-2010. Other spaces in the building may indicate receptacle control and shall use the same components and installation methods.

.2 In addition to the required room lighting control, each office or computer classroom shall be equipped with a relay/power supply to control at least 50% of the receptacle within the space.

.3 All controlled receptacles shall be grey in colour to identify them from receptacles with other functions.

.4 Control may be through remote relay panel serving larger spaces with multiple controls or individual local units. In each case, the relay shall be capable of switching plug loads and shall be certified by a testing authority for this function.

.5 Central relay panels shall be controlled via time-of-day control and shall be schedule to shut-off during non-operational hours.

.6 Relay designated as lighting relays are not acceptable to switch plug loads unless they have been separately certified as suitable for plug loads.

.7 Plug-in type power bars with built-in occupancy sensors cannot be used to meet this requirement.

2.8 EXTERIOR LIGHTING CONTROL

.1 Exterior lighting control system shall consist of a networked digital controller that shall provide astronomical time clock, control multiple relays, provide multiple inputs, and provide multiple time-of-day schedules. Each relay shall be able to be programmed individually or in groups to allow for multiple control options. Relay voltage rating shall match voltage of exterior lighting being controlled. Controller shall be capable to network with other controllers or relay cabinets to allow more relays or multiple voltages to be controlled from the one primary controller. Exterior lighting control system shall be LC&D Bluebox or equivalent.

.2 All building exterior lighting connected to building panels shall be controlled by relays within the lighting control system. Lighting to be included shall be safety lighting, parking lot lighting, area lighting, building mounted lighting, façade lighting, landscape lighting, advertising signage and illuminated signage.

.1 All building façade and landscape lighting shall be automatically shut off between midnight or building closing whichever is later, and 6am or business opening, whichever comes first, or between times established by the authority having jurisdiction.

.2 All other lighting, shall be controlled such that the lighting shall automatically reduce by at least 30% for at least one of the following conditions:

.1 From 12 midnight or within one (1) hour of the end of business operations, whichever is later, until 6 am or business opening, whichever is earlier; or
.2 During any period when no activity has been detected for a time of no longer than 15 minutes.

.3 All exterior lighting control systems shall include an exterior mounted, north-facing, weather-resistant, low voltage photosensor and shall be Cooper PPS-5 or equivalent. All exterior lighting shall be turned off by photosensor control.

2.9 EMERGENCY LIGHTING CONTROL

.1 Unless noted otherwise, all emergency lighting shall not be switched and shall provide illumination to Ontario Building Code requirements.

.2 Where emergency lighting is required and is installed in a space where lighting control is desired, an emergency lighting control unit will be installed. Location shown with an emergency battery unit meeting code requirements as shown on the drawings shall not require an emergency lighting control unit.

.3 The emergency lighting control unit shall allow control of emergency lighting fixtures in tandem with normal lighting in an area while ensuring that emergency lighting will turn on immediately to full brightness upon loss of normal power supplying the control device. Emergency lighting operation shall be independent for each controlled area and shall not require a generalized power failure for proper operation.

.4 The device shall have an integral momentary test switch. Pressing and holding this switch shall instantly force the unit into emergency mode and turn on emergency lighting. Releasing the test switch shall immediately return the unit to normal operation.

.5 The unit shall provide dedicated leads and 24 VDC source for connection to remote test switch, fire alarm system, or other external system capable of providing a normally closed dry contact closure. Breaking contact between the terminals shall force and hold the emergency lighting on until the terminals are again closed. An integral LED indicator shall indicate the unit's current remote activation status.

2.10 SPARE COMPONENTS

.1 Provide and turn over to the owner, after six month service visit, 10% spare (rounded up) wiring devices, sensors, buttons, relay modules and relays to allow minor future expansion and ongoing maintenance of lighting control system. Installer may use spare components to adjust owner's requirements at one month and six month visits. These spare components are not a replacement for defective components covered under warranty.

3 EXECUTION

3.1 INSTALLATION

.1 The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The contractor shall provide additional sensors and power supplies/relays as required to properly and completely cover the respective room and circuits.

.2 Locate and aim sensors within each space as required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations. Rooms shall have ninety (90) to one hundred (100) percent coverage of the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s).

.1 Occupancy sensors shall be placed to eliminate activation or minimize activation, in the case of multiple entries, from outside the room.

.2 Photosensors shall be placed close to sidelights and within toplight vertical sections, with lens facing as close to north as possible.

.3 It is the contractor’s responsibility to arrange a pre-installation meeting with manufacturer's factory authorized representative, at owner's facility, to verify placement of sensors and installation criteria.

.4 Proper judgment must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components. The contractor shall also provide, at the owner's facility, the training necessary to familiarize the owner's personnel with the operation, use, adjustment, and problem solving diagnosis of the occupancy sensing devices and systems.

.5 When installing occupancy sensors with ultrasonic sensors, the unit shall be mounted on a vibration free surface and shall installed a minimum of 1220 mm (48”) away from supply ducts, minimum of 1830 mm (72”) away from wall mounted discharge ducts, and minimum of 150 mm (6”) from the power supply.

.6 When installing occupancy sensors in areas where the area is too large to cover with a sensor(s) shown on drawings or the space has obstructions that do not meet the minimum coverage requirements, then multiple sensors shall cover zones to ensure that the proper coverage is achieved without additional cost to the owner.

.7 When an area is served by lighting on multiple circuits, a relay or contactor shall be provided to allow all lighting to be controlled by the sensor(s).

.8 When serving areas with high ceilings or exterior areas, sensors should be placed at manufacturer’s recommended height for coverage and spacing.

3.2 SITE QUALITY CONTROL

.1 Field Testing

.1 Upon completion of the installation, the system shall be completely tested by field technician who will verify all adjustments and sensor placement to ensure a trouble-free lighting control system and compliance with ASHRAE 90.1-2010 functional testing standards.

.2 Each device shall be numbered, labeled and recorded. Tests shall be conducted to ensure that entering the space shall ensure that lighting shall be activated as per requirements and the vacating a space will cause the lighting to turn off within 30 minutes.

.3 After one month and six months of customer use, the installer and/or manufacturer shall return to the site and make any required adjustments to location, control, sensitivity and timing as required by the users based on their feedback. Provide suitable feedback forms to owner’s representative two weeks prior to visit. Schedule visits with owner’s representative.

.2 Functional Testing

.1 The lighting control system shall be functionally tested in accordance with ASHRAE 90.1-2010 functional testing requirements. Manufacturer or contractor shall provide lighting control narrative and room-by-room control requirements.

.2 At a minimum the following procedures shall be performed:

.1 Confirm the placement, sensitivity and time out adjustments for occupancy sensors yield acceptable performance, lights turn off only after space is vacated and do not turn on unless space is occupied.
.2 Confirm that time switches and programmable schedule controls are programmed to turn the lights off.
.3 Confirm that photosensor controls reduce electric light levels based on the amount of usable daylight in the space as specified.

.3 Functional tester shall provide documentation certifying that the installed lighting controls meet or exceed all documented performance criteria.

.4 Lighting control system shall be complete, operational and all functional testing shall be completed within 7 calendar days of full occupancy.

.3 Training

.1 Provide on-site training to owner’s maintenance staff and operators to make adjustments to the system for further changes as required. Manufacturer shall provide minimum 12-month (from building occupancy) toll-free telephone support for technical questions concerning re-programming and technical issues.

.2 Training shall consist of one full-day session organized by manufacturer at approximately one month after owner occupancy. Training facilities shall be provided at owner’s site. Contact owner representative with at 3 weeks after occupancy to appropriate schedule time appropriate. Electronic and hardcopy of all slides and handouts used in training presentation shall be turn over to the owner.

END OF SECTION

1 GENERAL

1.1 INSTRUCTIONS

.1 Comply with the General Conditions of the Contract, the Supplementary Conditions, Division 01 – General Requirements, and Section 26 05 00 – Common Work Results for Electrical.

1.2 SUMMARY

.1 Provide all distribution equipment required for the complete installation.

.2 Refer to the "Power Distribution Single Line Diagram" and "Wiring for Mechanical Equipment Schedule" as shown on the drawings, for details of equipment and components to be provided.

1.3 REFERENCES

.1 Section 26 05 33 Raceway and Boxes for Electrical Systems

.2 Section 26 05 19 Wire and Cable

.3 Section 26 05 53 Identification for Electrical Systems

1.4 QUALITY ASSURANCE

.1 All equipment will be CSA approved and be finished in ANSI/ASA-61 light grey enamel paint.

.2 All equipment will be manufactured in accordance with the applicable sections of CSA Specification C22.2.

1.5 SUBMITTALS

.1 All distribution equipment for this project will have shop drawings submitted for review. Include product characteristics, performance criteria, physical size, finish and limitations.

.2 Maintenance and operating instructions, parts lists, etc., will be provided for any special function equipment.

.3 Include panel drilling dimensions and installation cut-out template.

2 PRODUCTS

2.1 APPROVED MANUFACTURERS

.1 Acceptable manufacturers are:

.1 Eaton Corp.

.2 Siemens Power.

.3 Schneider.

.4 ABB Inc.

2.2 DISTRIBUTION PANELS

.1 Fusible or circuit breaker type distribution panels will be provided as required to accommodate the indicated branch fused disconnect units or circuit breakers and spaces for future use as indicated on the Drawings. Panels will be of the type with voltage and current rating as indicated on the Drawings. Bus bracing will be provided to suit the short circuit capacity rating indicated on the Drawings or minimum 10 kA at 208 Volt, 3-phase or 14kA at 600 Volt, 3-phase as applicable.

.2 Fusible unit will have quick-make quick-break mechanism with provisions for locking in the open or closed position and door/switch interlock with override. All fusible units will be equipped for Class “J” HRC-1 fuses and include auxiliary contacts or other special features as noted on the drawings.

.3 Moulded case circuit breakers will be of the frame size and rating as shown on the drawings and include ground fault sensing relays, shunt trip, auxiliary contacts or other special features as noted on the drawings.

.4 Distribution panels will be complete with locking door, label, directory card and enclosure rated to suit the application.

.5 Flush mounted distribution panels will have doors and trims finished in ANSI/ASA-61 light grey enamel paint. Surface mounted distribution panels will have tubs, doors and trims finished in ANSI/ASA-61 light grey enamel paint.

.6 Provide sprinkler resistant hoods and doors for distribution panels installed in sprinklered areas.

2.3 CIRCUIT BREAKER PANELBOARDS

.1 Panels will be of the type, with voltage and current rating as indicated on the drawings. The panels will be sized to contain the specified branch breakers with space for future units as indicated.

.2 Panels will be complete with common key locking doors, and no label, stamp, or nameplate on the exterior of the panel trim or door. Provide a directory card and suitable holder mounted on the back of the panel door. Panel enclosure rating will suit application requirement.

.3 Flush mounted panelboards will have doors and trims finished in ANSI/ASA-61 light grey enamel paint. Surface mounted panelboards will have tubs, doors and trims finished in ANSI/ASA-61 light grey enamel paint.

.4 Unless otherwise indicated, circuit breakers will be moulded case type, with required frame size for trip settings as shown on the Drawings. Breakers mounted in panels will be bolt-on type.

.5 Unless otherwise noted all breakers will be rated minimum 14 kA symmetrical interrupting capacity at 600 volts, 3-phase or 10 kA symmetrical interrupting capacity at 208 volts, 3-phase as appropriate and not less than the short circuit capacity as shown on single line diagram drawings.

.6 Switching breakers will be UL SWD rated for switching duty.

.7 The circuit breaker servicing Life Safety Loads such fire alarm control panel will be paint red and lockable.

.8 Provide sprinkler resistant hoods and doors for panelboards installed in sprinklered areas.

3 EXECUTION

3.1 INSTALLATION

.1 Protect installed products and components from damage during construction. Repair damage to adjacent materials caused by equipment installation

.2 Install equipment in accordance with manufacturer's instructions or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

.3 All equipment installed in this scope will meet clearance requirements of the Electrical Code. Any equipment installed that does not meet this requirement will be reviewed with the Consultant.

.4 Free standing panelboards will be mounted on concrete housekeeping pads. The pad will be 100 mm (4") high and have 20 mm (3/4") chamfered edges. All exposed concrete surfaces will be finished smooth and level.

.5 Mounting heights of wall mounted panels will generally be 2000 mm (6'-6") to the top of the panel trim.

.6 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment

END OF SECTION

1 GENERAL

1.1 INSTRUCTIONS

.1 Comply with the General Conditions of the Contract, the Supplementary Conditions and the General Requirements of Division 01 and Section 26 05 00 Common Work Results for Electrical.

1.2 SUMMARY

.1 Section includes: Provide Wiring Devices, including but not limited to the following:

.1 Receptacles

.2 Coverplates

.3 Timers

.2 Related sections: The following is included for reference only and shall not be presumed complete:

.1 Section 26 05 33 - Raceways and Boxes for Electrical Systems

.2 Section 26 09 23 - Lighting Controls

.3 Section 27 05 28 - Pathways for Communications Systems

1.3 REFERENCES

.1 Abbreviations and Acronyms:

.1 AFCI: Arc Fault Circuit Interrupter

.2 GFI/GFCI: Ground Fault Circuit Interrupter

.3 UPS: Uninterruptible Power Supply

1.4 SUBMITTALS

.1 Submittals under this Section shall be in accordance with Division 01.

.2 Product Data:

.1 Submit manufacturer's Product data sheets for Products proposed for use in the Work of this Section. Include printed technical data, installation instructions and general recommendations for all materials and components. Include certification indicating compliance of materials with project requirements

.1 Special devices not listed in the Schedule of Wiring Devices.

.2 Flat Panel Display outlet boxes

2 PRODUCTS

2.1 MANUFACTURERS

.1 The products of the following manufacturers are acceptable subject to conformance with the requirements of the Drawings, Schedules and Specification:

.1 Acceptable Manufacturers:

.1 Hubbell

.2 Legrand - Pass & Seymour

.3 Eaton - Arrow Hart

.4 Bryant

.5 Leviton

.2 Products listed here are based on products and part numbers manufactured by Hubbell and indicate a level of quality and technical specification and is not an endorsement of the manufacturer.

2.2 MATERIALS

.1 All wiring devices and will be white in colour unless noted otherwise. Device part numbers shown represent required component series and are not meant to be exact part number or identify colour. The following special colours will be used:

.1 Red – Standby, Emergency or Essential Power

.2 Green – Controlled Circuit

.3 Black – Special receptacle not in CSA 5-15R or 5-20R configurations

.4 If an outlet exhibits more than one of the above properties, then a clear permanently-mounted label will be placed above the device stating all the other functions or properties of this wiring device.

.2 Schedule of Wiring Devices

.1 Standard Devices for use in light duty environments:

Description	**CSA/NEMA Configuration**	**Hubbell Part Number**
15 Ampere, 120 Volt, Decorator Duplex Receptacle	5-15R	DR15

Description	**CSA/NEMA Configuration**	**Hubbell Part Number**
20 Ampere, 120 Volt, T-Slot, Decorator Duplex Receptacle	5-20R	DR20
15 Ampere, 120 Volt, Decorator Duplex Receptacle, Controlled, Green (Series includes controlled, half controlled, and tamper resistant)	5-15R	DR15C Series
20 Ampere, 120 Volt, T-Slot, Decorator Duplex Receptacle, Controlled, Green (Series includes controlled, half controlled, and tamper resistant)	5-20R	DR20C Series
15 Ampere, 120 Volt, Duplex Receptacle with 5 Ampere, 5 Volt combination USB Type A and Type C charging ports.	5-15R	USB15AC5
5 Ampere, 5 Volt, 4-port USB Type A charging ports.	n/a	USB4

.2 Special mounting and accessories

.1 Flat Panel Display Wall box – 2-gang recessed FPTV Connection Enclosure Hubbell NSAV62M. Provide steel cover. Provide standard power kit and 1-gang decorator wall plate for Audio Visual or Telecommunications. For use with surface mounted flat screen displays only.

.2 Quad receptacle types are not permitted and will be substituted for two duplex receptacles ganged together.

.3 Provide other special wiring devices as noted on the drawings to the same quality as those listed within the “Schedule of Wiring Devices”.

.3 Receptacle Control

.1 Controlled receptacles should be clearly identified with green colour, controlled symbol, and the words “CONTROLLED” on the receptacle face of each receptacle being controlled. A clear permanently-mounted label will be placed above the receptacle stating “THIS OUTLET CONTROLLED BY OCCUPANCY”.

.2 Receptacle within the following spaces must be controlled wired or wirelessly via lighting control system as detailed in Section 26 09 23 Lighting Controls: conference rooms, rooms used primarily for printing and/or copying functions, and breakrooms.

.4 Interval Timers

.1 Provide Tork A560MHW or equivalent, SPDT type rated at 20 Ampere, 120 Volt AC complete with 60-minute spring wound twist timer with positive off position and 5-minute graduated faceplate for control of equipment as shown on the drawings.

.5 Coverplates

.1 Coverplates for wall mounted wiring devices in finished areas will be high impact smooth nylon coloured to match device. Where ganged devices have different colours, coverplate colour shall be white.

.2 In unfinished areas or surface mounted devices, coverplates will be galvanized type with rounded corners and back boxes will be cast type.

.3 Provide gasketed ‘While-in-Use’ or Extra Duty polycarbonate cover Hubbell RW58300 for all devices exposed to weather or water splashing. Cover will have ability to install padlock to restrict access and removal of installed plugs.

.4 Provide proper ganged coverplates and backboxes for all grouped outlets. Provide internal barriers between receptacles from different panels, and between receptacles and extra low voltage outlets.

3 EXECUTION

3.1 INSTALLATION

.1 All switches controlling a connected load in excess of 10 amperes will be 20 ampere rated type.

.2 Mounting heights of the wiring devices will be as follows unless subject to special installation conditions, or otherwise indicated on floor plans or dimensioned interior elevations (Mounting heights refer to the centre of the outlet box):

.1 Light Switches and Control Devices 1100 mm (43”).

.2 Wall Outlets and Receptacles 460 mm (18") or 150 mm (6”) above countertop or back splash as applicable.

.3 In barrier-free spaces and suites, mount light switches and control devices at 1050 mm (41.5”) above finished floor.

.3 Coverplates will be installed flush and level.

.4 Install wiring devices after wall construction and painting is complete.

.5 All wiring devices shown as being relocated on drawings will be replaced with new device and coverplate and will be connected to the existing circuit.

.6 Install all wall switches with the OFF position down. All CSA 5-15R and 5-20R configuration receptacles will be installed so the ground is in the bottom position.

.7 Where electrical outlets and wall mounted heating units occur at the same height and location, the outlets will be mounted below or beside the heater, unless noted otherwise.

.8 Work top mounted outlets will be above floor monument type securely fastened to work surface using a threaded connection to conduit system. Provide all required fittings, inserts and accessories required for approved mounting and connection.

.9 Outlets installed in millwork will be standard wall mounted versions, flush mounted into face of the appropriate vertical surface. Refer to millwork elevations and sections for further details.

.10 Install Tamper Resistant receptacles in dwelling units.

.11 Receptacles not on isolated ground will have a green bond wire bonded to the device grounding terminal, the back box it is located in, and bonded to the branch circuit panelboard ground bus.

.12 Prior to rough-in for wall outlets for flat screen displays, coordinate mounting height such that flat screen mounting bracket is not interfering with wall outlet. Care should be taken to ensure wall outlet is completely behind flat screen display when mounted. If outlet is completely behind flat screen cover will not be installed.

.13 All outlets installed in exterior locations will be weather resistant type and will be protected with an Extra Duty or while-in-use cover for allowing outlet to be covered even while in use.

3.2 SITE QUALITY CONTROL

.1 Site Tests and Inspections:

.1 When installation is complete, test operation of all devices. All defective devices shall be replaced and all defective wiring shall be repaired.

.1 Switches should be operated to ensure load is switching as expected.

.2 For CSA 5-15R and 5-20R configuration receptacles should be tested with handheld plug-in receptacle tester for open circuits, and reversed wiring. GFCI test shall be completed on all GFCI receptacles and circuits.

.3 For receptacles of other configurations, a multimeter shall be used to preform similar tests.

.2 Non-Conforming Work:

.1 Defective materials or quality of work, whenever found, at any time prior to acceptance of the work, shall be rejected regardless of previous inspection. Inspection will not relieve responsibility but is a precaution against oversight or errors.

.2 Replace damaged work which cannot be satisfactorily repaired, restored or cleaned, to the satisfaction of the Consultant at no additional cost to the Owner.

END OF SECTION

1 GENERAL

1.1 INSTRUCTIONS

.1 Comply with the General Conditions of the Contract, the Supplementary Conditions and the General Requirements of Division 01 (and Division 20 or 26).

1.2 SUMMARY

.1 Section includes: Provide fuses, including but not limited to the following:

.1 HRC Fuses

1.3 REFERENCES

.1 Reference Standards: Versions of the following standards current as of the date of issue of the project apply to the Work of this Section. Where regulatory requirements use older version of a standard, comply with the version year adopted by the Authority Having Jurisdiction

.1 Canadian Standards Association (CSA):

.1 CAN/CSA C22.2 No. 106 – HRC – Miscellaneous Fuses

.2 CSA 248 – Fuses for Supplementary Overcurrent Protection (600 Volts, Maximum)

1.4 SUBMITTALS

.1 Submittals under this Section shall be in accordance with Division 01.

.2 Product Data:

.1 Submit manufacturer's Product data sheets for Products proposed for use in the Work of this Section. Include printed technical data, installation instructions and general recommendations for all materials and components. Include certification indicating compliance of materials with project requirements

1.5 MAINTENANCE MATERIALS SUBMITTALS

.1 Spare Fuses:

.1 Supply a complete set of spare fuses in original packaging for all fused secondary distribution equipment. Quantity of spare fuses to match fuses installed.

.2 Unless otherwise specified, store the spare fuses in fuse storage cabinets.

2 PRODUCTS

2.1 MANUFACTURERS

.1 Single source responsibility: Obtain each type of product in this Section from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.

2.2 MATERIALS

.1 General

.1 Fuses are to be CSA certified and marked in accordance with the following Standards:

.1 HRC fuses – CAN/CSA C22.2 No. 106.

.2 Plug and cartridge fuses – CSA 248.

.2 HRC fuses are to have an interrupting capability of 200,000 A symmetrical.

.3 Unless otherwise specified, fuses are to be the products of one manufacturer.

.4 Fuse type references L1, L2, J1, R1, etc., have been adopted for use in this Specification.

.2 Fuse Types:

.1 Fuse types are to be as follows:

.1 HRC-J fuses (formerly Class J):

.1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.

.2 Type J2, fast acting.

.2 HRC-L fuses (formerly Class L):

.1 Type L1, time delay, capable of carrying 500% of its rated current for 10 s minimum.

.2 Type L2, fast acting.

.3 HRCI-R fuses (formerly Class R – for UL Class RK1 fuses, peak let-through current and 12t values are not to exceed limits of UL 198E table 10.2):

.1 Type R1 (UL Class RK1, time delay, capable of carrying 500% of its rated current for 10 s minimum to meet UL Class RK1 maximum let-through limits.

.2 Type R2, time delay, capable of carrying 500% of its current for 10 s minimum.

.3 Type R3 (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.

.4 HRCII-C fuses (formerly Class C)

3 EXECUTION

3.1 INSTALLATION

.1 Fuses:

.1 Install fuses for secondary distribution equipment in accordance with equipment specifications and drawing requirements. Ensure that the correct fuses are assigned to each electrical circuit.

.2 Generally, fuses are to be as follows:

.1 Motor loads, elevators & transformers: type J1 for up to and including 600 amperes and type L1 for ratings above 600 A.

.2 Service entrance feeder circuits: type J2 for up to and including 600 amperes and type L2 for ratings above 60 A.

.3 Other service and equipment: a type either indicated on the drawings, specified with the equipment, or required for the purpose.

.3 Ensure that circuit fuses are fitted to physically matched mounting devices. Provide Class R rejection clips for HRCI-R fuses.

END OF SECTION

1 GENERAL

1.1 INSTRUCTIONS

.1 Comply with the General Conditions of the Contract, the Supplementary Conditions, Division 01 – General Requirements, and Section 26 05 00 – Common Work Results for Electrical.

1.2 SUMMARY

.1 Section includes: Provide disconnect switches.

.2 Related sections: The following is included for reference only and shall not be presumed complete:

.1 Section 26 28 13 Fuses

1.3 REFERENCES

.1 Reference Standards: Versions of the following standards current as of the date of issue of the project apply to the Work of this Section. Where regulatory requirements use older version of a standard, comply with the version year adopted by the Authority Having Jurisdiction

.1 Canadian Standards Association (CSA):

.1 CSA – C22.2 No. 4 – Enclosed and Dead-Front Switches

1.4 SUBMITTALS

.1 Submittals under this Section shall be in accordance with Division 01.

.2 Product Data:

.1 Submit manufacturer's Product data sheets for disconnect switches and accessories proposed for use in the Work of this Section. Include printed technical data, installation instructions and general recommendations for all materials and components. Include certification indicating compliance of materials with project requirements

2 PRODUCTS

2.1 MANUFACTURERS

.1 The products of the following manufacturers are acceptable subject to conformance with the requirements of the Drawings, Schedules, and Specification:

.1 Acceptable manufacturers are:

.1 Rockwell Automation/Allen-Bradley

.2 Eaton

.3 Siemens

.4 Schneider Electric

.2 Requests for substitutions shall be made in conformance with Division 01.

.3 Single source responsibility: Obtain each type of product in this Section from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.

2.2 MATERIALS

.1 All disconnect switches are to be in accordance with requirements of CSA – C22.2 No. 4.

.2 Disconnect Switches:

.1 Heavy-duty front operated switches each in accordance with CSA – C22.2 No. 4, each complete with a red handle suitable for padlocking in the “off” position, and a NEMA/ EEMAC enclosure.

.2 Fusible units are to be complete with fuse clips in accordance with CSA-C22.2 No. 39, Fuseholder Assemblies and to suit fuse types specified below.

.3 Unless otherwise scheduled or specified fuses are to be equal to English Electric Ltd. HRC fuses, Form I Class “J” for constant running equipment and Form II Class “C” for equipment that cycles on and off.

.4 Provide viewing window that will allow visibility of the position of the blades.

.5 Enclosures: Unless otherwise specified, contactor enclosures are to be in accordance with the following NEMA/EEMAC ratings:

.1 All enclosures located in sprinklered areas – Type 2.

.2 All enclosures exposed to the elements – Type 3R, constructed of stainless steel.

.3 All enclosures inside the building in wet areas – Type 3R, constructed of stainless steel.

.4 All enclosures in washdown or food preparation areas - Type 12X, constructed of stainless steel.

.5 All enclosures in explosion rated area – Type 7 with exact requirements to suit the area and application.

.6 All enclosures except as noted above – Type 1.

3 EXECUTION

3.1 INSTALLATION

.1 Disconnect Switches:

.1 Install all required disconnect switches in accordance with drawing plans, schedules, details, and requirements of the Specification.

.2 Install fuses for fusible disconnects.

END OF SECTION

1 GENERAL

1.1 INSTRUCTIONS

.1 Comply with the General Conditions of the Contract, the Supplementary Conditions, Division 01 – General Requirements, and Section 26 05 00 – Common Work Results for Electrical.

1.2 SUMMARY

.1 Section includes: Provide contactors, including but not limited to the following:

.1 Contactor

.2 Enclosure

1.3 REFERENCES

.1 Reference Standards: Versions of the following standards current as of the date of issue of the project apply to the Work of this Section. Where regulatory requirements use older version of a standard, comply with the version year adopted by the Authority Having Jurisdiction.

.1 Canadian Standards Association (CSA):

.1 CSA C22.2 No. 14 – Industrial Control Equipment

.2 National Electrical Manufacturers Association (NEMA)

.1 NEMA ICS2 – Controllers, Contactors and Overload Relays

1.4 SUBMITTALS

.1 Submittals under this Section shall be in accordance with Division 01.

.2 Product Data:

.1 Submit manufacturer's Product data sheets for Products proposed for use in the Work of this Section. Include printed technical data, installation instructions and general recommendations for all materials and components. Include certification indicating compliance of materials with project requirements

.2 Product data is to include:

.1 Enclosure rating

.2 Short circuit withstand rating

.3 Nameplate information and schematic wiring diagram

.3 Manufacturer Reports:

.1 Start-Up and Site Certification Reports: Submit start-up and site certification reports as specified in Part 3 of this Section.

2 PRODUCTS

2.1 MANUFACTURERS

.1 The products of the following manufacturers are acceptable subject to conformance with the requirements of the Drawings, Schedules and Specification:

.1 Acceptable manufacturers are:

.1 Rockwell Automation/Allen-Bradley

.2 Eaton

.3 Siemen

.4 Schneider Electric

.2 Requests for substitutions shall be made in conformance with Division 01.

.3 Single source responsibility: Obtain each type of product in this Section from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.

2.2 MATERIALS

.1 Contactors:

.1 Supply in accordance with the requirements of CSA C22.2 No. 14 and NEMA ICS2.

.2 Modular design, factory assembled, electrically held (unless otherwise noted), full size contactors in accordance with requirements of CSA C22.2 No. 14 and NEMA ICS2. Unless otherwise shown or specified each contactor is to be complete with a nameplate, and the following:

.1 A padlockable enclosure with conduit knockouts and mounting screw holes conforming to requirements specified below.

.2 Enclosed contacts with closed contact indication.

.3 Unless otherwise indicated, two NC and two NC auxiliary plug-in contacts.

.4 A continuously rated interchangeable coil.

.5 Side access, finger-safe field wiring terminals to suit conductors indicated.

.6 A manual operator.

.7 As specified on the Drawings, optional factory installed accessories consisting of:

.1 A hand-off-selector switch.

.2 2 identified pushbuttons, 1 green for power on, and 1 push-to-test.

.3 A fuse and transformer kit.

.4 a fused door interlock disconnect switch.

.3 Enclosures: Unless otherwise specified, contactor enclosures are to be in accordance with the following NEMA/EEMAC ratings:

.1 All enclosures located in sprinklered areas – Type 2.

.2 All enclosures exposed to the elements – Type 3R, constructed of stainless steel.

.3 All enclosures inside the building in wet areas – Type 3R, constructed of stainless steel.

.4 All enclosures except as noted above – Type 1.

3 EXECUTION

3.1 INSTALLATION

.1 Installation Of Contactors

.1 Provide contactors where shown and secure in place.

.2 Connect each contactor with wiring in conduit in accordance with drawing requirements.

.3 Do all required interlocking work in accordance with drawing control diagrams and control sequence requirements.

3.2 SITE QUALITY CONTROL

.1 Manufacturer Services:

.1 When contactor installation is complete, arrange and pay for the manufacturer to visit the site to check the installation, and to supervise all required testing and adjusting. Submit a copy of a report from the manufacturer which certifies that each contactor has been properly installed and connected, and has been checked and adjusted, as specified in Part 1 of this Section.

END OF SECTION

1 GENERAL

1.1 INSTRUCTIONS

.1 Comply with the General Conditions of the Contract, the Supplementary Conditions, Division 01 – General Requirements, and Section 26 05 00 – Common Work Results for Electrical.

1.2 SUMMARY

.1 Section includes lighting fixtures complete with lamps, ballasts, drivers, lenses, etc.

.2 Equipment shall be compatible with the various building elements that affect the installation and operation of the units.

1.3 REFERENCES

.1 Provide fixtures that will meet the requirements of the various active government incentive programs such as Save-on-Energy, High Performance New Construction prescriptive path, etc.

1.4 SUBMITTALS

.1 Shop drawings for luminaires indicating lighting performance details, fixture construction details, air control and ductwork connection details, etc., and pictures of each type of lighting fixture shall be submitted for review.

.2 Shop drawings shall be submitted for LED drivers, ballasts, and bulbs for all fixtures to be installed. These shall be submitted separately from the lighting fixtures being installed and should indicate each fixture the product is installed.

.3 Fixtures which have been specially designed or altered shall have a full scale mock-up built and submitted for co-ordination and design review when requested by the Consultant.

.4 Mock-up fixtures must have engineering drawings submitted for approval, after the mock-up has been approved.

.5 Fixtures shall not be released prior to review of the shop drawings. Cancellation charges will not be paid for changes to fixtures made before the fixture cuts have been reviewed.

.6 Submittals under this Section shall be in accordance with Division 1 Submittals.

1.5 QUALITY ASSURANCE

.1 All lighting fixtures and components must be CSA approved, ULC approved, or approved by Special Inspection from the Electrical Safety Authority.

.2 Where stated, LED fixtures shall be DLC and/or Energy Star listed.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Light fixtures must be shipped in individual containers. The fixtures must be stored in a dry area protected from the elements and physical damage.

1.7 WARRANTY

.1 LED lamps and drivers shall be warrantied for minimum 5 years from date of final acceptance, all other lamps and ballasts for a minimum 1 year warranty period.

2 PRODUCTS

2.1 MANUFACTURERS

.1 The products of the following manufacturers are acceptable subject to conformance with the requirements of the Drawings, Schedules and Specification:

.1 Acceptable manufacturers are:

.1 Acuity

.2 Signify

.3 Cooper

.4 Hubbell

.2 Single source responsibility: Obtain each type of product in this Section from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.

2.2 LED LIGHT FIXTURES

.1 LED monochrome lighting fixture shall have lighting that shall a minimum CRI of 85 for regularly occupied spaces, a minimum CRI of 70 for exterior, and a minimum of 75 for all other spaces. The fixture shall have a minimum L70 of 50,000 hours. All lighting shall have IESNA LM-79 and LM-80 testing reports and life calculations based on TM-21. Exterior and interior area lighting shall have a minimum efficiency of 80 lumens per watt.

.2 LED drivers shall have minimum lifespan equal or better than the lifespan of the L70 lifespan of the LED lamps it serves. Drivers shall be integrated into the fixture if serving only that fixture or remote if the driver serves more than one fixture. All drivers shall be dimmable using 0-10V dimming technology unless noted otherwise. LED drivers shall have high power factor. All LED lighting and drivers used in exterior or unheated applications shall provide start-up and operation in temperatures from -30 °C to +50 °C.

2.3 LENSES

.1 All flat plastic lenses shall be a minimum 3.2 mm (1/8") thick acrylic type with no mid-span sag.

.2 All metal parabolic louvres shall be fabricated from low iridescent, semi-specular aluminum sheet with cell size, depth and quantity as indicated on fixture schedule. All parabolic louvres shall be shipped assembled in fixtures to prevent damage and be enclosed in a clear plastic wrap all around to prevent dust or dirt contamination. Plastic wrap shall not be removed until space is fully cleaned and approval to do so is granted by the Consultant.

.3 All special lenses shall be as specified in fixture schedule.

2.4 ACCESSORY PRODUCTS

.1 Air control and slot provision where applicable shall be fully co-ordinated with the Mechanical Trade for a fully compatible installation. Set dampers to fully blank of air slots where instructed.

2.5 SOURCE QUALITY CONTROL

.1 Lighting fixtures shall be provided with all auxiliary components and mounting hardware required for installation in the building as intended. Verify all catalog numbers with descriptions given including mounting, lamp type and quantity.

3 EXECUTION

3.1 INSTALLATION

.1 Ensure that both recessed and surface mounted light fixtures mounted as part of a suspended ceiling system are adequately supported. Fixtures shall not be suspended directly from the ceiling system supporting grid, but must be supported directly from the building structure.

.2 Surface mounted fixtures on T-Bar ceilings may be supported using a minimum of two "Caddy" IDS clips from the ceiling suspension grid and which are also separately connected to the building structure.

.3 Co-ordinate the requirements of the ceiling system supports with the Ceiling Contractor prior to fixture installation. Fixture safety chains or wires shall also be provided as required by regulatory agencies. The method of attaching suspension wires and safety chains or wires to fixtures and building elements, shall be discussed with and approved by the Consultant prior to installation. Where the structural system is to have a fireproofing material applied, attach all structural system fasteners in advance of the fireproofing.

.4 Pendant mounted fixtures shall have a deep canopy cover to fully cover the supporting outlet box and render it inconspicuous. Provide a self-aligning type cover and support for fixtures mounted to sloped surfaces.

.5 Electrical wiring or components shall not be attached to the ceiling system suspension wires.

.6 For exact details of fixture installation in valances, bulkheads, millwork, etc., refer to the Architectural Drawings.

.7 All electrical fixtures are to be delivered to the site with the specified finish. Where required colour or finish is not available from the fixture manufacturer, obtain such from an approved paint shop.

3.2 FIELD QUALITY CONTROL

.1 Check all lighting fixtures prior to their installation to ensure that they are the specified and approved fixtures for the project. Check the fixture catalogue number, frame and mounting arrangement, lens type, reflector type, lamp socket position, lamp type, fixture operating voltage, etc.

.2 The locations of fixtures are shown generally on the electrical drawings. For accurate locations refer to the architectural reflected ceiling plans (indoor) or landscape drawings (outdoor).

3.3 CLEANING

.1 Clean all lenses and interior of all fixtures.

END OF SECTION

1 GENERAL

1.1 INSTRUCTIONS

.1 Comply with the General Conditions of the Contract, the Supplementary Conditions, Division 01 – General Requirements, and Section 26 05 00 – Common Work Results for Electrical.

1.2 SUMMARY

.1 Provide Exit Lighting as shown on the drawings and in the lighting fixture schedule. Exit Lighting will be fed from an AC voltage dedicated circuit and a DC voltage source connected to the emergency battery lighting system.

.2 Provide complete 24 volt DC emergency battery lighting system for the building areas indicated. The emergency battery units will be located as indicated on the drawings. The emergency battery system will provide emergency power automatically on failure of the normal power supply system. When the normal power supply system is restored, the emergency battery unit will restore itself automatically to the charging condition.

1.3 REFERENCES

.1 Reference Codes and Standards: Versions of the following standards current as of the date of issue of the project apply to the Work of this Section. Where regulatory requirements use older version of a standard, comply with the version year adopted by the Authority Having Jurisdiction.

.1 CSA C22.2 No. 141 Emergency lighting equipment

.2 CAN/CSA C860 Performance of internally lighted exit signs.

.3 Ontario Building Code

.4 Ontario Electric Safety Code

.5 Section 26 50 00 Lighting

1.4 SUBMITTALS

.1 Complete sets of shop drawings will be submitted indicating the following:

.1 System components, specifications, and dimensions.

.2 Battery Calculations.

.3 Wiring schematics.

.2 For Closeout submittals provide the following:

.1 Emergency lighting runtime test report

1.5 QUALITY ASSURANCE

.1 All lighting fixtures and components must be CSA approved, ULC approved, or approved by Special Inspection from the Electrical Safety Authority.

1.6 STORAGE AND HANDLING

.1 The fixtures must be stored in a dry area protected from the elements and physical damage.

1.7 SPARES

.1 Provide the following quantity of spare devices:

.1 Two (2) exit lighting fixtures

.2 Four (4) double remote heads

.2 Include labour for the installation of the spare fixtures/devices if directed by the Authority Having Jurisdiction.

2 PRODUCTS

2.1 MANUFACTURERS

.1 The products of the following manufacturers are acceptable subject to conformance with the requirements of the Drawings, Schedules and Specification:

.1 Acceptable manufacturers are:

.1 Aimlite

.2 Beghelli

.3 Emergi-lite

.4 Lumacell

.5 Stanpro

.2 Single source responsibility: Obtain each type of product in this Section from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.

2.2 EXIT LIGHTING

.1 Housing: cold rolled steel minimum 1.0 mm (1/25 in) thick, die-cast or anodized extruded aluminum frame, white finish c/w universal mounting system.

.2 Face and back plates: extruded aluminum alloy white colour.

.3 Graphic: Green “running man” pictogram.

.4 Lamps: LED type, 120 V AC, maximum 5 watts consumption.

.5 Designed for minimum 50,000 hours of continuous operation without re-lamping.

.6 Exit lighting arrows: exit lighting will be capable of no arrows or configuration with arrows facing left, right, up, down, upper right, upper left, lower right, or lower left. “Running man” pictogram will also be capable of facing either right or left. Refer to drawings for orientation required for each exit lighting unit.

.7 Photoluminescent Exit signage is not permitted.

2.3 EMERGENCY BATTERY UNITS

.1 The self-powered battery units will be a sheet steel ventilated type enclosure with a removable front cover. The cabinets will be painted with a corrosion resistant undercoat inside and have a low gloss white enamel exterior finish. The side panel of the battery cabinets will contain an AC on light, charge light and test switch. A supply line fuse will be provided inside the cabinet. The emergency battery unit will be rated for AC power supply and be equipped with a grounded plug and power cord, minimum 4' in length for power supply connection.

.2 The emergency batteries will be long life sealed lead-acid (SLA) type and be VRLA technology totally maintenance free with a minimum life expectancy of 10 years.

.3 All emergency battery lighting heads on unit battery and remote will be LED type.

.4 The battery capacity will be sized to supply the number of fixtures indicated on the drawings, plus have an additional 50 watts spare capacity for future heads. The batteries will be capable of providing power to the fixtures for 30 minutes without dropping below ninety-one (91) percent of the rated battery voltage.

.5 The emergency battery charger will be a solid state, fully automatic rectifier type with Hi and Lo charging rates to re-charge the batteries to their rated capacity from a discharged condition in less than 24 hours.

.6 The emergency battery units will be complete with the following options:

.1 Electrolyte low level alarm.

.2 Battery disconnect switch (70 % of normal voltage).

.3 Time delay relay to maintain emergency lighting for 10 minutes, powered from the battery charger, following restoration of normal power.

.4 Auto test and automated self-diagnostic circuitry complying with CSA and building code requirements.

.7 Mounting platforms and accessories will be provided for a permanent and safe installation of the battery unit.

2.4 SOURCE QUALITY CONTROL

.1 Exit lighting fixtures shall be provided with all auxiliary components and mounting hardware required for installation in the building as intended. Verify all catalog numbers with descriptions given including mounting, lamp type and quantity.

3 EXECUTION

3.1 INSTALLATION

.1 EXIT LIGHTING

.1 Ensure that exit lighting AC circuit breaker is locked in on position

.2 Install exit lighting as indicated, in accordance with building code requirement.

.2 EMERGENCY BATTERY UNITS

.1 Provide grey coloured conductors in a separate conduit system, for the DC wiring. The wire will be sized to limit voltage drop to furthest fixture to 5 percent. Connect battery units to remote lamp heads and exit lighting emergency sockets in an approved manner.

.2 Emergency lighting will be so arranged that the failure of any one lamps will not leave in total darkness the area normally illuminated by it.

.3 Unit equipment will be installed in such a manner that it will be automatically actuated upon failure of the power supply to the normal lighting in the area covered by that unit equipment.

.4 Install battery unit mounting shelf at 2000 mm (80 in) above finished floor.

.5 All battery units will have a logged runtime test completed prior to occupancy to ensure compliance with building code requirements.

END OF SECTION

1 GENERAL

1.1 INSTRUCTIONS

.1 Comply with the General Conditions of the Contract, the Supplementary Conditions, Division 01 – General Requirements, and Section 26 05 00 – Common Work Results for Electrical.

1.2 SUMMARY

.1 Section includes: Provide pathways for communications and other extra low voltage systems, including but not limited to the following:

.1 Internal building horizontal pathways, service provider pathways, and exterior pathways.

.2 Outlet boxes, cover plates, conduits, cable trays, pull boxes, sleeves, backboards, telecom rooms, shafts, fish wires, innerduct, cable hooks, firestopping, cable managers, service fittings, and direct buried ducts.

.2 Related sections: The following is included for reference only and shall not be presumed complete:

.1 Division 07 - Firestopping

.2 Division 21 - Fire Suppression

.3 Division 22 - Plumbing

.4 Division 23 - Heating, Ventilating, and Air Conditioning (HVAC)

.5 Section 26 05 19 - Wire and Cable

.6 Section 26 05 33 - Raceway and Boxes for Electrical Systems

.7 Section 26 27 26 - Wiring Devices

1.3 REFERENCES

.1 Reference Standards: Versions of the following standards current as of the date of issue of the project apply to the Work of this Section. Where regulatory requirements use older version of a standard, comply with the version year adopted by the Authority Having Jurisdiction

.1 American National Standards Institute (ANSI)/ Telecommunications Industry Association (TIA):

.1 ANSI/TIA 569 – Telecommunications Pathways and Spaces

.2 ANSI/TIA 606 – Administration Standard for Telecommunications Infrastructure

.2 Ontario Building Code

.3 Ontario Electrical Safety Code

1.4 SUBMITTALS

.1 Submittals under this Section shall be in accordance with Division 01.

.2 Product Data:

.1 Submit manufacturer's Product data sheets for Products proposed for use in the Work of this Section. Include printed technical data, installation instructions and general recommendations for all materials and components. Include certification indicating compliance of materials with project requirements

.1 Fire Rated Pathways

2 PRODUCTS

2.1 MANUFACTURERS

.1 The products of the following manufacturers are acceptable subject to conformance with the requirements of the Drawings, Schedules and Specification:

.1 Acceptable Manufacturers:

.1 Fire-rated Pathways:

.1 STI EZ-Path

.2 Hilti Firestop Speed Sleeve

.2 Requests for substitutions shall be made in conformance with Division 01.

2.2 MATERIALS

.1 Service Entrance:

.1 Install fibre optic, data, telephone and cable TV service provider ducts in a direct buried rigid PVC duct sized and located as shown on the drawings.

.2 Internal Distribution:

.1 Interior conduit to be EMT unless specifically noted or required to be otherwise.

.2 Exterior conduit to be PVC unless specifically noted or required to be otherwise.

.3 Conduit not indicated as to size to be 25 mm (1 in) minimum.

.4 LB fittings are not allowed under any conditions.

.3 Distribution Terminations:

.1 Provide 19 mm (3/4 in) fire retardant painted (all six sides) plywood wall mounted equipment mounting backboards as shown for telecommunications rooms.

.2 Provide conduits terminated with an insulated bushing to area ceiling spaces and telecom rooms as shown for zone conduit or sleeve installations.

.4 Outlets:

.1 Wall outlets consist of standard deep single gang outlet boxes unless otherwise indicated. Provide blank coverplates for all un-used outlets.

.2 Coverplates complete with appropriate jacks are provided by extra low voltage systems providers.

.5 Fire-Rated Cable Pathways:

.1 Fire-Rated Pathway device modules are comprised of steel pathway with self-adjusting intumescent foam pads allowing 0% to 100% cable fill without removal of intumescent material.

.2 Quantity and size of pathway are based on the fill area listed on the drawings or minimum sizes listed below. Provide uniform sized of devices where more than one device is required at same location.

.3 Unless noted on the drawings, the minimum clear space sizes are:

.1 160 cm^2 (25 in^2) for telecommunications rooms

.2 for cable tray penetrations, provide minimum size equal to cross-sectional area of cable tray

.3 80 cm^2 (12.5 in^2) in corridors without cable trays

.4 8 cm^2 (1.25 in^2) for room penetrations

3 EXECUTION

3.1 INSTALLATION

.1 Install fibre optic, data, telephone, and cable TV service provider ducts in a direct buried rigid PVC duct sized and located as shown on the drawings.

.2 Install empty raceway system, including distribution system, fish wire, outlet boxes, floor boxes, pull boxes, cover plates, conduit, sleeves, cable tray, service poles, miscellaneous and positioning material to constitute complete system.

.3 Run parallel to building lines all horizontal and vertical pathways. Do not route diagonally for extended distances.

.4 Since cabling for communications is subject to many add/moves/changes in future, install pathways in locations that are readily accessible in future and route below ductwork and piping in ceiling spaces. Coordinate installation of pathways with Division 21, Division 22, and Division 23 to minimize interference and maximize accessibility to pathways.

.5 Horizontal data cables from telecommunications rooms patch panels have limitation of cable length of 90 m (297 ft). Optimize pathways to minimize cable length.

.6 Protect installed products and components from damage during construction.

.7 Repair damage to adjacent materials caused by pathways for communications systems installation

.8 Bury underground service ducts a minimum of 900 mm (36 in) below finished grade.

.9 Restrict installation of conduits as follows:

.1 60 m (200 ft) maximum no bends

.2 45 m (150 ft) maximum with equivalent of one 90º bend

.3 30 m (100 ft) maximum with equivalent of two 90º bends

.4 20 m (65 ft) maximum with equivalent of three 90º bends

.5 No more than three 90º bends are allowed in any section of conduit run

.10 Install all conduits with large radius bends. Minimum bending radii is 10 times the diameter.

.11 Provide 25 mm (1 in) conduit from the main telephone demarcation to the building fire alarm control panel, main intrusion alarm panel, and each elevator machine room. Provide cost during construction period for temporary telephone connection to each of the above listed systems for testing and/or commissioning until full building occupancy or the owner's permanent line is installed.

.12 Provide a 19 mm (3/4 in) conduit from the service provider's entrance backboard to the building electrical service ground point and install a #6 ground conductor for service ground connections.

.13 Mounting heights of the communications outlets unless otherwise noted are as follows:

.1 Standard wall outlet 460 mm (16 in) or 150 mm (6 in) above countertop or splash back

.2 Wall mounted telephones outlets 1100 mm (43 in) to centre of backbox

.3 When mounting adjacent to other devices at same location, communications outlet box to match installation height of adjacent outlet box used for wiring device

.14 Refer to the systems conduit diagrams for details of distribution and outlet conduit, cabinet and backboard requirements and to floor plans for component and outlet locations.

.15 Contact Owner's systems service providers as appropriate to verify all incoming conduit sizes, prior to proceeding with installations. Modify provisions accordingly to suit their specific requirements. Co-operate with appropriate installation personnel during construction and give sufficient notice of construction progress to allow scheduling of their installations. Systems installation companies/contractors generally supply and install distribution cable, terminals, equipment and connectors to complete systems installations. Co-ordinate and arrange for all work to suit construction phasing as appropriate.

.16 Install nylon pull cords in all empty conduits and tag and identify both ends appropriately. Maintain a pull cord in all conduit systems used only to partial capacity.

.17 Firestopping

.1 Install at all fire separations Fire-Rated Pathway device modules to allow future cables to be installed through fire separation. Prepare and install device module as per manufacturer’s instructions.

.2 Use Fire-Rated Pathway device module only for extra low voltage systems cabling and do not use for line voltage applications.

END OF SECTION

1 GENERAL

1.1 INSTRUCTIONS

.1 Comply with the General Conditions of the Contract, the Supplementary Conditions, Division 01 – General Requirements, and Section 26 05 00 – Common Work Results for Electrical.

1.2 SUMMARY

.1 Section includes: Provide complete structured cabling systems, including but not limited to the following:

.1 Telecommunications cabling

.2 Outlet jacks and plugs

.3 Patch panels and termination blocks

.4 Racks and cabinets

.5 Grounding busbars and bonding

.6 Labelling

.7 Firestopping

.8 Testing and certification.

.2 Products furnished/supplied but not installed under this section:

.1 Patch cord and line cords

.3 Related sections: The following is included for reference only and shall not be presumed complete:

.1 26 05 19 Wire and Cable

.2 27 05 28 Pathways for Communications Systems

1.3 REFERENCES

.1 Abbreviations and Acronyms:

.1 “MPTL” is defined as Modular Plug Terminated Link.

.2 “U” is defined as a rack unit of measure for rack mounted equipment and is equivalent to 44.45 mm (1.75 in) as defined in EIA-310. This term is preceded by an integer without a space indicating the multiplier of the rack unit height (for example 3U is equivalent to 133.35 mm (5.25 in) or three rack units).

.3 “WAP” is defined as Wireless Access Point.

.2 Definitions:

.1 “Category 3" or “Cat 3” is defined as a 4-pair unshielded twisted pair cable with cable performance defined to 16 MHz to meet or exceed the ANSI/TIA-568.2 Category 3 Specifications. This term applies to cable and connecting hardware for component, link and channel performance.

.2 “Category 5", “enhanced Category 5" and “Category 5e” or “Cat 5e” is defined as a 4-pair unshielded twisted pair cable with cable performance defined to 100 MHz to meet or exceed the ANSI/TIA-568.2 enhanced Category 5 Specifications. This term applies to cable and connecting hardware for component, link and channel performance.

.3 “Category 6" or “Cat 6” is defined as a 4-pair unshielded twisted pair cable with cable performance defined to 250 MHz to meet or exceed the ANSI/TIA-568.2 Category 6 Specifications. This term applies to cable and connecting hardware for component, link and channel performance.

.4 “Category 6A" or “Cat 6A” is defined as a 4-pair unshielded twisted pair cable with cable performance defined to 500 MHz to meet or exceed the ANSI/TIA-568.2 Category 6A Specifications. This term applies to cable and connecting hardware for component, link and channel performance.

.5 “OM3” is defined as a laser-optimized 50/125 µm Multimode fibre optic cable with cable performance to meet or exceed the ANSI/TIA-568.3 OM3 Specifications. This term applies to cable and connecting hardware for component, link and channel performance. Jacket colour is aqua.

.6 “OM4” is defined as a laser-optimized 50/125 µm Multimode fibre optic cable with cable performance to meet or exceed the ANSI/TIA-568.3 OM4 Specifications. This term applies to cable and connecting hardware for component, link and channel performance. Jacket colour is aqua.

.7 “OM5” is defined as a wideband 50/125 µm Multimode fibre optic cable with cable performance to meet or exceed the ANSI/TIA-568.3 OM5 Specifications. This term applies to cable and connecting hardware for component, link and channel performance. Jacket colour is lime green.

.8 “OS2” is defined as a loose tube 8/125 µm Singlemode fibre optic cable with cable performance to meet or exceed the ANSI/TIA-568.3 OS2 Specifications. This term applies to cable and connecting hardware for component, link and channel performance. Jacket colour is yellow.

.9 “PoE” is defined as Power over Ethernet and delivers data communications and power up to 100 W to meet or exceed requirements of IEEE-802.3af (15 W), IEEE-802.3at (30W), and IEEE-802.3bt (60 W and 100 W).

.3 Reference Standards: Versions of the following standards current as of the date of issue of the project apply to the Work of this Section. Where regulatory requirements use older version of a standard, comply with the version year adopted by the Authority Having Jurisdiction

.1 American National Standards Institute (ANSI)/ Institute for Electrical and Electronics Engineering (IEEE):

.1 ANSI/IEEE 802.3 Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.

.2 ANSI/IEEE 802.3z Gigabit Ethernet Specifications over Fibre Optic Cabling

.3 ANSI/IEEE 802.3ab Gigabit Ethernet Specifications over UTP Cabling

.4 ANSI/IEEE 802.3ae Media Access Control Parameters, Physical Layers and Management Parameters for 10 Gb/s Operation

.5 ANSI/IEEE 802.3af Data Terminal Equipment (DTE) Power via Media Dependent Interface (MDI)

.6 ANSI/IEEE 802.3at Data Terminal Equipment (DTE) Power via Media Dependent Interface (MDI) Enhancements

.7 ANSI/IEEE 802.3bt DTE Power via MDI over 4-Pair

.2 American National Standards Institute (ANSI)/ Telecommunications Industry Association (TIA):

.1 ANSI/TIA 568.0 – Generic Telecommunication Cabling for Customer Premises

.2 ANSI/TIA 568.1 – Commercial Building Telecommunications Infrastructure Standard

.3 ANSI/TIA 568.2 – Balanced Twisted-Pair Telecommunications Cabling and Components

.4 ANSI/TIA 568.3 – Optical Fiber Cabling and Components

.5 ANSI/TIA 568.4 – Broadband Coaxial Cabling and Components

.6 ANSI/TIA 569 – Commercial Building Standard for Telecommunications Pathways and Spaces

.7 ANSI/TIA 570 – Residential Telecommunications Wiring Standard

.8 ANSI/TIA 606 – Administration Standard for the Telecommunications Infrastructure

.9 ANSI/TIA 607 – Commercial Building Grounding/Bonding Requirements

.10 ANSI/TIA 758 – Customer-Owned Outside Plant Telecommunications Infrastructure Standard

.11 ANSI/TIA 862 – Structured Cabling Infrastructure Standard for Intelligent Building Systems

.12 ANSI/TIA 942 – Telecommunications Infrastructure Standard for Data Centers

.13 ANSI/TIA-1152 – Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling

.3 Building Industry Consulting Service International (BICSI):

.1 ANSI/NECA/BICSI 607 – Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings

.2 BICSI – Telecommunications Distribution Methods Manual

.3 BICSI – Cabling Installation Manual.

.4 Electrical Industry Association (EIA):

.1 EIA-310 – Cabinets, Racks, Panels, and Associated Equipment

.5 International Standards Organization (ISO):

.1 IEC/ISO 11801 – Generic Cabling for Customer Premises

.6 Ontario Building Code

.7 Ontario Electrical Safety Code

.8 Cabling system manufacturers' design and installation guidelines

1.4 ADMINISTRATIVE REQUIREMENTS

.1 Coordination:

.1 All work shall be coordinated with other trades prior to commencing work.

.2 When installing material in a space where ceiling tiles and access floor tile have already been installed or are existing, this section to:

.1 remove and replace all associated tiles,

.2 perform tile cutouts for work directly related to contractor supplied material, and

.3 replace any tiles damaged at no additional cost to the owner. Tiles shall match existing.

.3 Coordinate with owner's service provider technicians, network integrator, and owner's forces for active equipment installation and associated cabling and services to that equipment.

.2 Scheduling:

.1 Weekend and/or evening scheduling may be required for completion of the project within the specified schedule. Include such scheduling requirements, refer to Division 01 for further scheduling requirements, in all bid pricing.

.2 Installation of system furniture workstation outlets will be done after hours immediately prior to owner's move-in. Coordinate installation with system furniture installer and ensure that all outlets are fully terminated and tested prior to owner's move-in. Ensure that sufficient labour is available and include all associated overtime costs in bid pricing.

.3 Schedule work within telecommunications rooms to be completed early to allow owner to complete installation and testing of active equipment. Allow at least two weeks prior to owner occupancy for this work to be completed. Horizontal cable testing and labelling may be preformed after this deadline.

1.5 SUBMITTALS

.1 Submittals under this Section shall be in accordance with Division 1 Submittals.

.2 Product Data:

.1 Submit manufacturer's Product data sheets for Products proposed for use in the Work of this Section. Include printed technical data, installation instructions and general recommendations for all materials and components. Include certification indicating compliance of materials with project requirements

.1 Cable and Component Cutsheets

.2 Racks/Cabinets

.3 Power Bars

.4 Cords

.5 Grounding busbars

.6 Labeller and labels

.7 Testing equipment to be used

.3 Certificates:

.1 Provide manufacturer's certificate indicating application assurance and application warranty for provided cabling and components for minimum of 15 years.

.4 Test and Evaluation Reports:

.1 Provide electronic copy of summary and full test results in sorted and searchable PDF format. Summary to be sorted by cable label and show a single line for each cable with the minimum information of: field label, channel loss, length, and pass/fail. Provide complete test results in a single combined non-secured, searchable PDF sorted by cable label. If graphical test results are available from tester, provide legible PDF of results and native formatting for information with free viewing software for current version of Microsoft Windows.

1.6 CLOSEOUT SUBMITTALS

.1 Submittals under this Section shall be in conformance with Division 1.

.2 Operation and Maintenance Manuals:

.1 Including the following:

.1 Product data sheets

.2 Structured Cabling Testing Report

.3 Firestopping Report

.3 Warranty Documents:

.1 Shall be in conformance with Division 1.

.2 Provide manufacturer's certificate indicating application assurance and application warranty for provided cabling and components for minimum of 15 years.

.4 Record Documents:

.1 As-built Drawings including but not limited to the following:

.1 Outlet final locations

.2 Cable labelling for horizontal and backbone

.3 Telecommunications rooms layouts

.4 Rack/Cabinet final elevations

.5 Software:

.1 All software required to view test results in native format in PC format.

1.7 QUALITY ASSURANCE

.1 Qualifications:

.1 Manufacturer's:

.1 Manufacturer shall have a minimum of 5 years' experience having successfully supplied products required for the Work of this Section for other projects of similar size and complexity.

.2 Installer's:

.1 Installer shall have a minimum of 5 years' continuous Canadian experience successfully completing projects similar in size and complexity as the Work of this Section. Submit proof of experience upon Consultant's request.

.2 Provide all system installations by a cabling system manufacturer certified installer with qualified and accredited technicians experienced with the specific work detailed in this Section. All subcontractors hired under this Section must also meet these criteria.

1.8 WARRANTY

.1 Manufacturer Warranty:

.1 Provide a minimum 15-year manufacturers' product warranty against defects in materials and workmanship from the date of substantial completion.

2 PRODUCTS

2.1 OWNER FURNISHED PRODUCTS

.1 Owner's Network Equipment:

.1 Core and network switches not connected directly to PoE Lighting.

.2 Routers, Firewalls, Storage Area Networks, and Servers

.3 Wireless Access Points (WAP)

.4 Fibre optic patch cords to the above equipment

.2 Service Provider Equipment:

.1 Gateways, Routers, Firewalls, Amplifiers, and Splitters

.2 Building entrance surge protection for above equipment

.3 Associated patch cord and cross-connects with above equipment.

2.2 MANUFACTURERS

.1 The products of the following manufacturers are acceptable subject to conformance with the requirements of the Drawings, Schedules and Specification:

.1 Acceptable Manufacturers:

.1 Belden

.2 Commscope

.3 Hubbell

.4 Panduit

.2 Single source responsibility: Obtain each type of product in this Section from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.

2.3 MATERIALS

.1 Backbone Copper Cabling:

.1 Copper backbone cable is multi-pair 24 AWG solid copper conductor voice-grade unshielded twisted pair cable with color coded insulation and overall jacket. Fire rating is listed as FT4 (CMR).

.2 In telecom rooms, terminate backbone copper cabling onto 19-inch rack-mountable patch panels to match horizontal copper cabling installation.

.3 In main telecom room, terminate backbone copper cabling on Belden BIX-block cross-connect system.

.4 Between BIX voice terminations in main telecom room, provide 1-pair unshielded twisted-pair cross-connects.

.5 Between horizontal patch panels and backbone patch panels in telecom room, supply 4-conductor flat telephone line cords terminated on both ends with a 6-pin (RJ-11) modular plug. Determine lengths on site by field conditions to minimize slack cable. Provide quantity of patch cords equal to number of horizontal voice outlets.

.2 Fibre Optic Cabling:

.1 Intrabuilding backbone fibre optic cable to be OS2 optical fibre factory terminated onto MPO connectors at each end. Fire rating is listed as FT4 (OFNR) for cabling routed between telecom spaces.

.2 Intrabuilding backbone data cabling termination onto rack-mountable fibre optic patch panel with factory-terminated modular fibre optic cassettes. Modular fibre optic cassettes to have MPO connector at rear of cassette and have ceramic ferrule, duplex LC optical fibre connectors at front.

.3 Interbuilding backbone fibre optic cable to be OS2 optical fibre.

.4 Interbuilding backbone data cabling termination onto rack-mountable fibre optic patch panel with field-terminated splice trays. Splice tray then would factory-terminate to modular inserts with ceramic ferrule, duplex LC optical fibre connectors at front.

.5 Fibre optic patch cords

.1 Duplex LC male connectors at both ends unless noted otherwise. Quantity and length as determined on drawings.

.3 Category Copper Cable:

.1 All cabling and components to be ANSI/TIA-568.2 standard Category 6A or better.

.2 Four twisted-pair copper cables, connectors, and patching:

.1 Unshielded twisted pair

.2 Cable fire rating: CMR or CMP depending on application and fire code

.3 In damp or wet locations, use cable jacket and label rated for outdoor use. Cable connectors at each end of cable:

.1 Terminations: 8 position 8 contact (8P8C), modular, pinned for T568A and T568B configurations.

.2 Default connector to be female modular jack.

.3 Ceiling terminations use male MPTL (modular plug terminated link) connector for the following applications:

.1 Wireless Access Points (WAP)

.2 Video Surveillance Cameras

.4 Patch Cords:

.1 Patch Cords are used within a telecom space to connect from a patch panel to active equipment.

.2 4-pair unshielded twisted pair, 24 AWG, stranded copper modular with male 8-pin modular connector at each end.

.3 Determine lengths on site by field conditions to minimize slack cable using factory standard lengths.

.4 Quantity of cords to equal number of horizontal outlets.

.5 Cords to be factory terminated and tested.

.6 Cord to match manufacturer of horizontal cable and Category rating.

.5 Line Cords:

.1 Line cords are used within a floor area to connect between a horizontal outlet and equipment.

.2 4-pair unshielded twisted pair, 24 AWG, copper modular with male 8-pin modular connector at each end.

.3 Lengths of line cords to be as follows: 50% at 3 m (10 ft), 30% at 7m (23 ft), and 20% at 10 m (33 ft).

.4 Quantity of cords to equal number of horizontal outlets.

.5 Cords to be factory terminated and tested.

.6 Line cords passing free-air through ceiling space to be FT6 (CMP) fire rated.

.7 Cord to match manufacturer of horizontal cable and Category rating.

.6 Copper Patch Panels:

.1 At termination racks or cabinets, supply quantity of flat copper patch panels, with individual openings (ports) sized for modular jacks, to accommodate all modular jacks terminated at rack. Accommodate 48 ports for each patch panel. If less than 12 ports remain unfilled, supply one additional patch panel to accommodate future modular jacks. For each 48 ports provide one horizontal 2U high channel-style cable management panel.

.7 Termination Blocks:

.1 Terminate copper voice cabling on Belden BIX-block cross-connect system. Follow all recommended practices by manufacturer when installing mounts, distribution connectors, and wire management accessories. Wall mount BIX-blocks on painted 20 mm (3/4 in) fire-rated plywood backboard.

.4 Wireless Access Points (WAP):

.1 All cabling to be rated Category 6A. Otherwise match properties of Category copper cables detailed above.

.5 Long Reach Locations:

.1 For locations where cabling lies beyond 90 m (297 ft), supply a system that will allow data to reach the remote location.

.1 Powered fibre optic cabling and media conversion

.2 Passive or active PoE extenders

.3 For outdoor locations with multiple connections, hardened managed network switch

.2 Provide all associated power supplies to convert from local 120 V AC sources.

.3 Provide appropriate weather-resistant lockable enclosures for all exterior mounted equipment. Supply hardened equipment in outdoor locations that operate at -40 ºC (-40 ºF) to 50 ºC (122 ºF) without supplemental heating/cooling. For exterior WAP or radio locations, supply non-metallic enclosures.

.4 Provide surge protection for all copper cabling routing from exterior locations upon re-entry to building. Surge protection provided shall not degrade the cable performance.

.6 Equipment Mounting:

.1 Provide open frame steel 2-post equipment racks with flanged base, 19-inch mounting rails drilled front and back and tapped to EIA 310 spacing standards with a minimum of 44U in height. On each side of individual racks, include a full-height vertical cable management channel with a minimum width of 300 mm (12 in) between racks and 150 mm (6 in) on ends.

.2 Unless noted otherwise on drawing, on rear of rack supply two vertically mounted unswitched power strips with a minimum of eight CSA 5-20R receptacles each, with bottom fed 2.5 m (8 ft) cord with CSA L5-20P power connector. Racks containing only patch panels require a single power strip.

.7 Grounding Busbar:

.1 Supply tin-plated copper busbar on backboard within each telecommunications room. Busbar to be mounted with insulators and mounting bracket. Busbars to meet ANSI/NECA/BICSI 607 requirements.

.1 Main Telecommunications room supply 6 mm x 102 mm x 508 mm (0.25 in x 4 in x 20 in) with both 6 mm (1/4 in) stud holes with 16 mm (5/8 in) hole spacing and 10 mm (3/8 in) stud holes with 25 mm (1 in) hole spacing.

.2 All other telecommunications spaces supply 6 mm x 51 mm x 305 mm (0.25 in x 2 in x 12 in) with both 6 mm (1/4 in) stud holes with 16 mm (5/8 in) hole spacing and 10 mm (3/8 in) stud holes with 25 mm (1 in) hole spacing.

.2 Supply copper ground bar at bottom of all racks or cabinets and suitable for 6 AWG 2-hole lug connectors.

.3 Supply 2-hole lug connectors for all terminations to busbars.

.8 Horizontal Outlets:

.1 For standalone wall faceplates, supply up to 6-port per gang white faceplates to mount jacks.

.2 For combined power/telecom wall faceplates, supply white 3-port decorator style insert plates for mounting horizontal jacks within combined faceplate.

.3 For combined power/telecom multi-gang floor boxes, supply white 3-port decorator style insert plates for mounting horizontal jacks within floor box faceplate.

.4 For wall telephone locations, supply 1-port stainless steel telephone faceplates with dual mounting posts. Port to be suitable for 8-pin jack.

.5 For furniture mounted jacks, supply mounting faceplate suitable for furniture manufacturers openings. Only if there is no suitable faceplate, supply surface mount enclosure for housing jacks.

.6 Mount all ports with manufacturer's supplied jack. Supply blank port covers for all unused ports within faceplates.

.9 Labelling:

.1 Labelling to meet ANSI/TIA-606 standards and owner's nomenclature requirements. Include entire tag on labels. All final labels to be white, vinyl, machine printed using a legible sans serif font. All ink to be black, non-smudging, water resistant, and fade resistant.

.2 For cabinet/rack minimum 36-point

.3 For patch panel minimum 24-point

.4 For cables wrap around self-laminating cable labels with a minimum 10-point

.5 Each horizontal jack minimum 8-point

.10 Finishes:

.1 Colours used shall match that of the system being supplied. These colours apply to cable, jacks, and cords.

.1 Backbone Fibre Optic – as determined by cable type

.2 Backbone Copper – Grey

.3 Horizontal Data – Blue

.4 Horizontal Voice – White

.5 Audio Visual – Black

.6 Video Surveillance – Violet

.7 Wireless Access Points – Orange

.8 Bonding/Grounding – Green

3 EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions:

.1 Examine all work of other Sections upon which the Work of this Section depends.

.2 Report in writing to the Consultant/Project Manager any defects of surfaces or work prepared by other Sections which affect the quality or dimensions of the Work of this Section.

.3 Do not proceed with Work of this Section until all unsatisfactory conditions have been rectified and site conditions are ready to receive work.

.4 Commencement of work implies acceptance of existing conditions and work by others.

3.2 PREPARATION

.1 Protection of In-Place Conditions:

.1 Effectively protect the owner's facilities, equipment and materials from dust, dirt and damage during construction. Remove any protection at the completion of each shift unless the protection endangers work in progress or personal safety. Removal and replacement of ceiling or floor tiles to be the responsibly of this section. Replace all cable damaged from lack of effective protection during construction period with no additional cost to the owner. All areas should be cleaned of debris generated by this work at the completion of each shift.

.2 Preparation:

.1 Prior to pathway rough-in, coordinate the installation of all telecommunications infrastructure routing with Section 27 05 28 to resolve all interferences and cabling infrastructure requirements. Provided that final outlet locations are within the total shown and the average cable length to the telecommunications room does not change more than 3 m (10 ft) per cable, no additional costs to be paid for location changes.

.3 Demolition / Removal:

.1 Exercise extreme caution when working at or near any live connections to ensure that no interruption to active users occurs. Repair all interruptions immediately at full cost to this section.

.2 Completely remove and dispose of all existing cabling, terminations, faceplates, patch panels within the space to source unless indicated on the drawings or labeled for future use.

3.3 INSTALLATION

.1 Install all cabling, components, and equipment detailed in this section unless noted otherwise.

.2 Install cabling and components according to applicable standards and cabling system manufacturer's specifications, including cable stress, bending radius, maximum length, separation from other services, etc. All backbone and horizontal cabling to be continuous. No splicing is permitted except as noted.

.3 Splices to be permitted for intrabuilding fibre optic cabling. Ensure all fibre optic cable splice loss is equal to or less than 0.2 dB.

.4 The use of J-Hooks will not be allowed.

.5 Do not lay cabling or any other components on the ceiling tile or equipment withing ceiling.

.6 Terminate all copper category cabling in T568A configuration, unless existing installation is already terminated in T568B configuration.

.7 Within ceiling space above horizontal jack or connector location install a minimum of 1000 mm (39 in) of looped spare cable for future jack relocation. Support independently all looped spare cabling using J-Hooks as per Section 27 05 28. Do not lay looped spare cabling in cable tray or on any other components on the ceiling tile.

.8 For backbone copper installations, for each 25 pairs in a multi-pair cable, terminate onto 24 patch panel jacks, sequentially connecting each pair in cable to pair 1 of each patch panel jack. Neatly terminate and dress all cables in the rear of the panel.

.9 Neatly dress and comb all cabling to the backboard, tray, and racks.

.10 Enclose non-armoured fibre optic cable in conduit or corrugated tubing outside of each rack/cabinet within telecom rooms.

.11 Fill in all unused ports, inserts, and coverplates with manufacturer's blank.

.12 Labelling:

.1 Install labelling at following locations:

.1 Cabinet/Rack

.2 Patch Panel

.3 Cable at each terminus

.4 Each horizontal jack

.13 Bundling:

.1 When travelling along the same route in free-air or cable tray, neatly bundle more than two like cables together to maintain cable organization. Limit each bundle to 48 cables to limit cable overheating and performance issues. Do not mix cable types within same bundle.

.2 The use of plastic cable ties may be used for cable bundling outside of telecommunications spaces. Wide band Velcro-based ties to be used to allow cables to be easily added to or removed from bundles. Never cinch ties so tight that the cable jackets deform or bend beyond cable manufacturer's recommended limits.

.14 Telecommunications Grounding and Bonding:

.1 Follow regulations for grounding and bonding of communications equipment as per Electrical Code, ANSI/TIA-607, and ANSI/NECA/BICSI-607.

.2 Install backbone copper bonding conductor sized to ANSI/TIA-607 requirements:

.1 Between main electrical room main ground bus and the main telecommunications room busbar.

.2 Between main telecommunication room busbar and each telecommunication room busbar.

.3 Install 6 AWG copper with green jacket from telecommunications busbar to all racks, cabinets, exposed steel structural columns, electrical panels ground bus to circuit supplying equipment in telecom room, cable trays, and access floor.

.4 All cable tray shall have copper 6 AWG bonding wire for the entire length with connection made at each section. If tray splits, each leg shall also be bonded in similar manner. Bond all communications cable tray to telecommunications room busbar.

.5 Use 2-hole crimp type connectors for all bonding and grounding connections to busbars.

.15 Interface with Other Work:

.1 Firestopping:

.1 Firestop all penetrations through the integrity of fire-rated architectural structures and assemblies, such as walls, ceilings and floors to maintain the structure's fire rating. Provide firestop within conduits or open spaces of cable trays. Conform all firestop penetrations to a specific ULC system number. All firestopping systems used for telecommunications cabling to use reusable materials (putty, pillows, etc.) unless directed by the engineer.

.2 Install firestopping material regardless if other non-firestopped penetrations through the fire separation are visible. If existing opening through fire separation is used, firestop entire opening and all other associated penetrations through that opening. If other trades use this opening as part of the scope of work of the project, then the cost of firestopping to shared among all trades using opening. If the opening is existing and used for structured cabling in this scope and is not firestopped, this Section to firestop the entire opening.

.3 Provide at each firestop penetration a fluorescent colored label indicating the following information: unique identification number, contractor name, date installed, ULC system number, cable type installed, and cable quantity. Provide a firestopping report with cable test results summarizing all firestop label information with photo of final installation.

3.4 SITE QUALITY CONTROL

.1 Site Tests and Inspections:

.1 Performance test using the most current available test methods and equipment installations. Provide all meters, tools and associated equipment and the services of technicians as required to carry out all testing.

.2 On completion of the installation of the system, provide tests to show that these specifications have been met both physically and functionally. All defects need to be rectified before final acceptance of the system. All test results to use field labelling and not default tester numbering.

.3 Provide electronic copy of summary and full test results in sorted and searchable PDF format. Summary to be sorted by cable label and show a single line for each cable with the minimum information of: field label, channel loss, length, and pass/fail. Provide complete test results in a single combined non-secured, searchable PDF sorted by cable label. If graphical test results are available from tester, provide legible PDF of results and native formatting for information with free viewing software for current version of Microsoft Windows.

.4 For testing that fails, complete re-termination or replacement of entire cable run. After re-installation, re-test all failed cabling. Submitted test report to show only passed tests.

.5 Test all installed fibre optic cabling to show that the installed cabling meets performance parameters of the manufacturer and ANSI/TIA-568.3.

.1 Pre-terminated cable requires only testing of insertion loss of an installed fiber optic cable plant performed with a light source and power meter (LSPM) or optical loss test set (OLTS) for each port to ensure no damage was caused to cable during installation.

.2 Intrabuilding fibre optic cable to have insertion loss and Optical Time-Domain Reflectometer (OTDR) testing for each terminated port.

.6 Test all installed copper cabling to show that the installed cabling meets performance parameters of the manufacturer, ANSI/TIA-568.2, and ANSI/TIA-1152 for the Category of cable installed.

.7 Test all installed coaxial cabling to show that the installed cabling meets performance parameters of the manufacturer and ANSI/TIA-568.4.

.2 Non-Conforming Work:

.1 Defective materials or quality of work, whenever found, at any time prior to acceptance of the work, shall be rejected regardless of previous inspection. Inspection will not relieve responsibility, but is a precaution against oversight or errors.

.2 Replace damaged work which cannot be satisfactorily repaired, restored or cleaned, to the satisfaction of the Consultant at no additional cost to the Owner.

.3 Manufacturer Services:

.1 Have manufacturer's technical representative inspect the Work at suitable intervals during application, and at conclusion of the Work of this Section, to ensure the Work is correctly installed. Submit manufacturer's inspection reports and verifications that the Work of this Section is correctly installed.

END OF SECTION

1 GENERAL

1.1 INSTRUCTIONS

.1 Comply with the General Conditions of the Contract, the Supplementary Conditions, Division 01 – General Requirements, and Section 26 05 00 – Common Work Results for Electrical.

1.2 SUMMARY

.1 Provide an electrically supervised, non-coded, closed circuit, single stage, addressable, zone annunciated evacuation fire alarm system. The system control panel operating procedures shall be contained in programmable software instructions to allow alterations to suit the specific building requirements. The system shall use multiplex communication techniques to transmit data to the system annunciators remotely located throughout the building. The control panel shall be microprocessor based to increase system reliability and speed response to alarm conditions.

.2 The system shall consist of a fire alarm control panel, manual pull stations, automatic thermal detectors, smoke detectors, trouble and alarm signals and remote annunciator panels as specified herein. The system shall contain all required components for alarm receiving circuits and signal circuits as shown on the drawings. The system shall be so arranged that the operation of any manual pull station or automatic thermal or smoke detector or sprinkler flow switch shall activate system signalling sequence. All system circuits, wiring and devices shall be fully supervised for faults. A circuit fault such as an open or ground or actuation of a valve tamper switch shall sound the trouble signal but shall not cause a false alarm.

.3 The system shall use full digital communications to supervise all addressable loop devices for placement, correct location, and operation. It shall allow swapping of “same type” devices without the need of addressing and impose the “location” parameters on replacement device. It shall initiate and maintain a trouble if a device is added to a loop and clear the trouble when the new device is mapped and defined into the system.

.4 On failure of the normal A.C. power source, the fire alarm control panel shall automatically switch to standby battery power. When the normal A.C. power is restored, the fire alarm control panel shall automatically switch back to A.C. operation and the battery pack shall be automatically recharged. The system is to be designed for 120 volts, AC single phase power supply.

.5 The existing fire alarm system control panel is not suitable for expansion or re-use and must be completely replaced.

1.3 SUBMITTALS

.1 Submittals under this Section shall be in accordance with Section 26 05 00 Common Work Results for Electrical.

.2 Product Data:

.1 Submit manufacturer's Product data sheets for Products proposed for use in the Work of this Section. Include printed technical data, installation instructions and general recommendations for all materials and components. Include certification indicating compliance of materials with project requirements

.3 Complete sets of shop drawings shall be submitted indicating the following:

.1 System component number and dimensions.

.2 System operating characteristics and functions.

.3 Rough-in details.

.4 Wiring schematics.

1.4 QUALITY ASSURANCE

.1 The fire alarm system shall be installed in accordance with the requirements of all applicable regulatory agencies and codes including:

.1 CAN/ULC-S1001 – Standard for Integrated Systems Testing

.2 CAN/ULC-S524 – Standard for Installation of Fire Alarm Systems

.3 CAN/ULC-S537 – Standard for Verification of Fire Alarm Systems

.4 Ontario Building Code

.5 Ontario Electrical Safety Code

.2 Employ fully trained mechanics who are regularly employed in the field of graphics design and/or sign production to create the fire alarm zoning graphic.

.3 Arrange for production of all graphic material.

1.5 RELATED WORK

.1 Coordinate work in this Section with all related Sections. Work and/or equipment provided in other Sections and related to the fire detection and alarm system will include, but not be limited to:

.1 Sprinkler waterflow and supervisory switches will be furnished and installed as detailed in Division 21 Fire Suppression but wired and connected under this section. Modification of existing sprinkler devices to accommodate monitoring by the new fire alarm system will be the responsibility of this Section.

.2 Duct smoke detectors will be furnished, wired and connected under this Section. Division 23 Heating, Ventilating, and Air Conditioning (HVAC) will furnish necessary duct opening to install the duct smoke detectors.

.3 Air handling and smoke exhaust system fan control circuits and status contacts to be provided by the HVAC control equipment as part of Division 25 Integrated Automation and connected to Fire Alarm System by this Section.

.4 Elevator recall control circuits to be provided by Division 14 Conveying Equipment and connected to Fire Alarm System by this Section.

.5 Dry pipe/deluge sprinkler system release valve control circuits and supervision contacts will be provided by Division 21 Fire Suppression and connected to Fire Alarm System by this Section.

1.6 SYSTEM OPERATION

.1 All fire alarm stations, thermal detectors, products of combustion detectors, emergency evacuation speakers, emergency telephone, sprinkler system flow switches, and sprinkler/standpipe tamper switches shall be fully supervised.

.2 The fire alarm system shall function such that the activation of any detection circuit will result in the following system operation:

.1 Cause audible signal devices to sound continuously throughout building.

.2 Activate all strobe appliances throughout the facility.

.3 Cause zone of alarm device to be indicated on control panel and remote annunciator panels.

.4 Cause fan systems to shut-down and electrically help open fire separation doors to close.

.5 Transmit a signal to the fire signal receiving centre or direct to municipal fire department.

.6 Transmit signal to elevator machine rooms for possible future special service operation.

.7 The system shall indicate trouble at the fire alarm control panel and remote annunciation devices when any fault occurs within the system.

.3 The auxiliary circuit connections shall provide automatic operation of auxiliary equipment with manual override on a circuit basis provided by panel control switches.

1.7 SYSTEM PROVISIONS

.1 The system shall display both alarm and trouble indications from each fire alarm detection zone. The activities of the system shall be complete with custom labels, indicating the exact location of the activity, and shall be displayed on the fire alarm control panel and remote annunciator panels.

.2 As a result of alarm conditions received the fire alarm control panel shall have the ability to automatically operate specified control points such as transmitting a signal to the fire signal receiving centre to summon the fire department, or stopping recirculating fan systems, closing fire separation doors, etc.

.3 The system shall be equipped with a communication input/output port to allow use of remote printers and video display terminals for remote status indication.

.4 The multiplex system shall be equipped with standby batteries and automatic charger to provide system operation and vital fire protection during commercial power outages. It shall also have provisions to operate remote LCD/LED annunciators. Annunciators shall be operable from the system communication circuits.

2 PRODUCTS

2.1 APPROVED MANUFACTURERS

.1 Listed below are manufacturers that will provide complete fire alarm panel. Equivalent fire alarm systems by other suppliers and/or engine manufacturer may be accepted subject to review by the consultant. Fire Alarm Systems by the following manufacturer/model combinations will be considered for use on this project:

.1 Edwards Quickstart QS4

.2 Simplex 4010ES

.3 Mircom FX-350

2.2 GENERAL

.1 Provide all modifications and additions to the existing installations to incorporate the new control equipment and other work and comply with the latest codes and regulations. Consult the manufacturer to verify the existing system provisions and include all necessary modifications to comply with the system requirements as described.

.2 Replace all existing system wiring to comply with new system specified requirements. Upgrade existing wiring arrangements to suit zoning changes, changing from series wired signal bells to parallel wired signal bells, the addition of smoke detectors in existing areas, changing from a standard to multiplex type system, etc. Existing conduit and raceways may be used for new wiring where appropriate.

.3 All equipment and components shall be the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling fire alarm and smoke control system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system. Provide, from the acceptable manufacturer's current product lines, equipment and components, which comply, with the requirements of these specifications.

.4 The system shall utilize node-to-node, direct wired, multi-priority peer-to-peer network operations. The system shall utilize electronically addressed, smoke detectors, heat detectors and input/output modules as described in this specification.

.5 All integrated life safety system equipment shall be arranged and programmed to provide an integrated system for the early detection of fire, the notification of building occupants, the automatic summoning of the local fire department, the override of the HVAC system operation, and the activation of other auxiliary systems to inhibit the spread of smoke and fire, and to facilitate the safe evacuation of building occupants. In all operating modes, the processing of fire alarms shall have the highest priority.

2.3 CONTROL PANEL

.1 Supply and install a new Fire Alarm Control Panel (FACP) to incorporate new work, comply with the latest Codes and allow temporary reconnection of all exiting circuits until wiring and devices are updated. Consult the manufacturer to verify existing system provisions and the compatibility of the new control equipment with existing system and provide all necessary modifications to existing wiring or new panel accordingly. Remove all special modifications upon completion of system wiring and device upgrade. All existing auxiliary control circuits shall be reconnected to new control to operate in the specified manner.

.2 The new fire alarm communication system central control panel shall be a multiplex and microprocessor based, single stage, type equipped for the required detection, supervisory, signal and auxiliary circuit capacity as shown on the Drawings.

.3 The control panel shall be housed in a surface cabinet and have a full viewing window through which all annunciator indication and operating instructions are clearly visible. Opening the panel doors shall provide access to all operating controls and electrical connections. All control circuits and protective devices are to be contained behind the dead front panel. All control modules shall be labeled, and all zone locations shall be identified.

.4 The control unit shall utilize microprocessor and multiplex technology and include the system hardware, software and memory in addition to all switches, indicating devices and other necessary electronic hardware. The control unit shall react to system inputs according to programmed instructions and control/operate specified control points and auxiliary circuits in correct timed operating sequences. These will include automatic equipment shutdown or start-up, automatic door release, operate audible and visual signal devices, operate trouble signals, activate municipal contact, etc.

.5 A minimum default single stage alarm system operation shall be supported with alarm silence, event silence, drill, lamp test, and reset common controls. The system shall be programmable for single, 2-stage or staged evacuation operation.

.6 The system shall have a CPU watchdog circuit to initiate trouble should the CPU fail.

.7 The system shall have a ULC Listed Detector Sensitivity test feature, which will be a function of the smoke detectors and performed automatically every 4 hours.

.8 The status/command section of the panel shall include as a minimum the following system indicators and controls:

.1 Power on and system on standby LED's.

.2 System trouble LED, audible alarm and silence switch.

.3 Signal silence pushbutton and indicating LED.

.4 System reset switch.

.5 Lamp test switch.

.6 Separate alarm and trouble indications for each detection, supervisory and signal circuit.

.7 Control switches to allow individual manual override of all auxiliary control circuits.

.9 The panel shall have an interface module for remote site monitoring. The module shall have a dialer Digital Alarm Communicator Transmitter (DACT) module to transmit alarm, supervisory and trouble signals to a Central Monitoring Station (CMS). The DACT shall support dual telephones lines, Contact ID communications, and configured for dual tone multi-frequency (DTMF) or pulse modes. It shall be possible to delay AC power failure reports, auto test call, and be site programmable. The dialer shall be capable of transmitting every individual alarm condition to the central station.

.10 The control panel shall be modular in construction for ease of expansion and servicing. Each individual function shall be on a replaceable plug-in panel or module to accommodate functional changes as required. All plug-in modules and panel connectors are to be supervised to give a trouble signal if damaged, removed or disconnected.

.11 The fire alarm control panel shall be provided with the following features:

.1 Auxiliary alarm and trouble contacts and connector strips (relay panel) for control of auxiliary circuits.

.2 Automatic signal silence after 20 minutes

.3 Municipal alarm connection contacts with disconnect device, indicating lamp and auxiliary contact.

.4 Lamp supervision.

.5 Subsequent alarm control.

.6 Integrated Dialer

.1 An optional integrated Digital Alarm Communicator Transmitter (DACT) shall provide communications, modem capability and LCD display functions.

.2 The DACT shall be capable of transmitting event messages to a primary and secondary central monitoring station receiver.
.3 The system shall be capable of transmitting information via Contact ID or SIA 4/2 protocols using single or dual line operation.
.4 The modules integrated Liquid Crystal Display (LCD) shall provide the system operator with detailed information about the off-normal status of the installed Fire Alarm / Life Safety System.
.5 The LCD shall automatically display that status of the system on the front panel display visible with the door closed.

.12 Each control panel shall support a standard 10/100 Base-T Ethernet network connection for panel programming and diagnostics.

2.4 STANDBY POWER

.1 Provide a 24V DC power supply with standby battery pack and automatic charger housed inside the main control panel. The batteries shall be gelled electrolyte type. The battery packs shall be sized in accordance with Building Code and CAN/ULC-S524, including capacity for special function 24V DC auxiliary control circuits (24 hr. supervisory, 30 minute alarm - battery, 30 minute alarm - generator). The presence of the battery pack and the wiring to the battery pack shall be electrically supervised; a fault shall energize the trouble circuitry.

.2 A fully automatic battery charger shall be provided. Charger shall be rated for re-charging batteries in accordance with latest Building Code and CAN/ULC-S524 requirements. The charger shall have no consumable parts or fuses. Short circuiting the charger's output on reversing the battery connectors shall cause no damage but shall initiate a trouble signal.

.3 The power transfer mechanism shall be solid state to ensure reliable operation and shall transfer to standby battery under brown out conditions. The battery shall be protected against excessive discharge by an automatic trouble alarm if the battery drops below 22.5 volts.

2.5 SYSTEM CONFIGURATION

.1 Each detection or signal loop shall be circuited so device loading is not to exceed 80% of loop capacity in order to allow for the addition of future devices.

.2 Provide alarm receiving modules in the control panel for all alarm receiving circuits. Modules shall include an individual amber trouble lamp for each alarm receiving circuit to indicate the source of any faults.

.3 The alarm receiving circuits shall have Class "A” operation. A single break or ground fault in the wiring to any initiating device shall cause a trouble signal, but shall not affect detection of an alarm from any initiating device while this fault exists.

.4 Provide supervisory receiving modules in the control panel for all supervisory circuits. Modules shall include individual alarm and trouble lamps for each supervisory circuit to indicate circuit condition.

.5 The supervisory circuits shall have Class "B" operation. A single break or ground fault in the wiring to any initiating device shall provide a trouble signal. A supervisory circuit alarm condition shall activate trouble sequence only.

.6 Provide audible signal circuit modules in control panel for all signal circuits. Modules shall include individual alarm and trouble lamps for each signal circuit to indicate the circuit condition.

.7 Provide auxiliary control relay modules in control panel for all auxiliary control circuits. Modules shall include individual trouble lamps for each circuit and supervised on-off-auto control switch for manual circuit operation override.

.8 The signal and auxiliary control circuits shall have Class "B" operation. A single break or ground fault in the wiring to any audible signal or control device shall produce a trouble signal.

2.6 SYSTEM DEVICES

.1 All new system devices shall be fully compatible with control equipment and match in operation and performance characteristics. All signal bells and manual pull stations shall be identical in appearance.

.2 Manual Pull Stations types include:

.1 Manual Station, Single Stage, single-action pull lever, extruded aluminum with NO/NC contacts.

.3 Manual Pull stations will include these accessories where required:

.1 Where surface mounted, use a vendor approved surface wall box.

.2 Where indicated on drawings provide a vendor approved polycarbonate shield and frame that fits easily over manual pull station. The shield will have integrated battery-operated horn.

.3 Use manufacturer-approved manual pull station lowering kit to adjust height of existing manual pull stations.

.4 The automatic thermal detectors shall be the following:

.1 Fixed and Rate of Rise Heat Detector. 57 ºC (135 ºF), separate mounting base.

.2 Fixed and Rate of Rise Heat Detector. 90 ºC (194 ºF), with addressable module.

.3 Fixed Temperature Heat Detector. 57 ºC (135 ºF), separate mounting base.

.4 Fixed Temperature Heat Detector. 90 ºC (194 ºF), with addressable module.

.5 Fixed and Rate of Rise Heat Detector. 57 ºC (135 ºF), Suitable for moisture proof application with an address module.

.6 Fixed Temperature Heat Detector. 57 ºC (135 ºF), suitable for moisture proof application with an address module.

.5 Where indicated to provide a fire detector, provide suitable thermal detector listed above.

.6 The automatic smoke detectors shall be the following:

.1 Photoelectric Area Type with separate mounting base

.2 Photoelectric Type Duct Smoke Detector with housing, Form-C shut down relay and LED remote indicator and sampling tubes to suit duct dimensions and key-operated remote test station. Provide wall mount remote indicator minimum 300 mm (1 ft) below ceiling at detector location.

.3 Photoelectric Smoke and Fixed Temperature Type- intelligent multi-sensor detector. The smoke detector will be modular and allow for replacement of the photoelectric chamber

.4 Ionization, Photoelectric and Heat Type - multi-sensor detector with a separate mounting base.

.7 Provide relay type base for area smoke detectors as indicated to provide a remote alarm indication or perform auxiliary functions as applicable. Relay bases to be 4 wire version with end of line relay. Power source for relay activation to be run separately from detection circuit to allow multiple unit operation.

.8 The intelligent Analog detectors will be suitable for mounting on any detector-mounting base.

.1 Standard Detector Mounting Bases - The base will be capable of supporting one Remote Alarm LED Indicator. Provide remote LED alarm indicators where shown on the plans.

.2 Relay Detector Mounting Bases – The base will be provided for area smoke detectors as indicated on plans to provide a remote alarm indication or perform auxiliary functions as applicable. Relay bases to be 4 wire version with end of line relay. Power source for relay activation to be run separately from detection circuit to allow multiple unit operation. The relay will be a bi-stable type and selectable for normally open or normally closed operation. The position of the contact will be supervised

.3 Isolator Detector Mounting Bases – The base's respective detector processor will control the operation of the isolator base. Following a short circuit condition, each isolator/detector will be capable of performing an internal self-test procedure to re-establish normal operation.

.4 Audible Bases - For synchronized output of the 3-3-3 pulse for room smoke detector annunciation. The audible bases will be used to provide audible signals to suites and dorm rooms. The power for the audible bases will be provided by the FACP or Booster power supplies and will be supervised with a riser supervisory module. The sounder bases can be controlled by the program so that the sounders can be turned on for general alarm evacuation signaling as well as inter suite alarm annunciation.

.9 Input modules will have a minimum of 2 diagnostic LEDs mounted behind a finished cover plate. A green LED will flash to confirm communication with the loop controller. A red LED will flash to display alarm status.

.1 Single Input Module - (Waterflow Detectors, Tamper Switches etc.) The Single Input Module will provide one (1) supervised Class B input circuit capable of a minimum of 4 personalities, each with a distinct operation. The single input module will support the following circuit types: Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.), Normally-Open Alarm Delayed Latching (Waterflow Switches), Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.), Normally-Open Active Latching (Supervisory, Tamper Switches).

.2 Dual Input Module - The Dual Input Module will provide two (2) supervised Class B input circuits each capable of a minimum of 4 personalities, each with a distinct operation. The dual input module will support the following circuit types: Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.), Normally-Open Alarm Delayed Latching (Waterflow Switches), Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.), Normally-Open Active Latching (Supervisory, Tamper Switches).

.3 Single Input Signal Module - The Single Input (Single Riser Select) Signal Module will provide one (1) supervised Class B output circuit capable of a minimum of 2 personalities, each with a distinct operation. When selected as a telephone power selector, the module will be capable of generating its own “ring tone”. The single input signal module will support the following operations: Audible/Visible Signal Power Selector (Polarized 24 V DC @ 2 A).

.4 Control Relay Module - The Control Relay Module will provide one form “R” dry relay contact rated at 2 A @ 24 V DC to control external appliances or equipment shutdown. The control relay will be rated for pilot duty and releasing systems. The position of the relay contact will be confirmed by the system firmware.

.10 End-of-line resistors shall be mounted behind a white plastic single gang cover plate appropriately marked and must be U.L.C. approved.

.11 Provide wire guard installed over detector for detector protection where appropriate.

.12 Notification appliances will be as follows:

.1 Horns: with a field selectable peak output of L_A = 97 dB at 10 feet at high output and L_A = 92 dB at low output. Horn to have a red finish. Horn output to be set at L_A = 97 dB unless noted otherwise. When surface mounted use surface wall box with a colour to match device.

.2 Strobes: synchronized strobe with a field selectable output of 15, 30, 75 or 110 cd; complete with red finish. To be selected for 15 cd for corridors and 75 cd for rooms unless noted otherwise on plans. When surface mounted use surface wall box with a colour to match device.

.3 Combination Horn-Strobes: with a field selectable peak output of L_A = 97 dB at 10 feet at high output and L_A = 92 dB at low output. Unit to be complete with a synchronized strobe with a field selectable output of 15, 30, 75 or 110 cd. Horn/strobe to have a red finish. Horn output to be set at L_A = 97 dB and strobe to be selected for 15 cd for corridors and 75 cd for rooms unless noted otherwise. Multi-candela strobe with intensity selectable as: 15, 30, 75 or 110 cd. When surface mounted use surface wall box with a colour to match device.

.4 Trim Plates: Provide trim plates for two-gang or 100 mm (4 in) square boxes.

.13 Fire alarm system manufacturer to include one (1) spare additional signal circuit.

.14 Provide remote annunciator at locations shown on drawing. Remote annunciator LED and LCD shall mirror those of the fire alarm control panel LED and LCD display functions for alarm, supervisory, monitor and trouble indications and common system controls including acknowledging, silencing, resetting and testing.

.15 Provide annunciators complete with common audible and visual trouble indication. Annunciators shall identify all system detection zones with spare zones. Annunciators shall have basic common control adder module behind a locking front panel incorporating power on, trouble and signal silence visual indications, audible trouble indication and control switches for signal silence, trouble silence, and lamp test. These common control features shall be connected to the common control to provide duplicate operator controls. Annunciator shall include required control and communication components for fully supervised connection to common control. The annunciators shall be solid state design using digital communication techniques to interface with the control panel. The annunciators shall be housed in flush or surface mounted wall cabinets as shown and be complete with a tamperproof cover. Replace all existing annunciators as noted on drawings.

.16 Fire Alarm Zoning Graphic

.1 Provide Fire Alarm Zoning Graphic adjacent to each control panel and annunciator.

.2 Sample Graphic

.1 Submit a sample of the graphic to the Consultant prior to the colouring and final framing process for approval.

.3 Rejections

.1 Defective materials or workmanship whenever found at any time prior to final acceptance of work shall be rejected regardless of previous inspection. Inspection will not relieve responsibility but is a precaution against oversight and error.

.4 Colour

.1 Building walls: Black

.2 Symbols and Text: Black ("You are here" marker to be red).

.3 Zones: Each zone to be a different colour as selected by the Consultant.

.5 Materials shall be new and in perfect condition, free from defects impairing physical or appearance performance.

.6 Graphic: 450 mm x 610 mm (18" x 24") high impact styrene with screened graphics. Zone colours shall be as selected by the Consultant from the standard range samples provided by this <Contractor/Sub-Contractors.

.7 Frame: Clear anodized aluminum picture frame with nominal 19 mm (3/4") face width.

.8 Protective Covering: Minimum 3 mm (1/8") thick, non-glare acrylic.

.9 Text font will be a light sans serif typeface and have a minimum text size of 10 point. All text should be upright and horizontal regardless of the rotation of the plan.

.10 The following information is required to be shown on the fire alarm zoning graphic:

.1 All exterior and interior walls.

.2 All stairs and elevators.

.3 All door openings.

.4 Exit door locations indicated with arrows pointing out from door and "Exit" label.

.5 "You are here" marker and text.

.6 North arrow.

.7 Annunciator panel location.

.8 Fire alarm zones and zone designations.

.9 Legend.

.11 Floor plan shall be rotated and oriented such that when viewing the graphic, and standing in front of it, the direction the viewer is looking is up on the floor plan.

3 EXECUTION

3.1 GENERAL

.1 It is the intention to provide the new fire alarm system work without any interruption of the existing fire alarm system protection in the building. Maintain fire alarm system operation during construction in accordance with "Guidelines for Maintaining Fire Safety During Construction in Existing Buildings." Any required testing of the fire alarm system during construction must be proceeded by a warning and announcement to the appropriated supervisory personnel. Arrange the time and duration of testing with the Owner to cause minimal disturbance and inconvenience to all concerned.

.2 Take alternate measures in co-ordination with the hospital during any temporary interruption or reduction of fire alarm detection or signalling to ensure the safety of the building occupants. These measures shall be approved by the local fire department and be conveyed to them in writing in accordance with the requirements of the Ontario Fire Code.

3.2 WIRING

.1 Wiring shall be sized and colour coded in accordance with manufacturer's and Electrical Safety Code requirements, (minimum #14 - signal and control circuits, minimum #18 - annunciation, minimum #16 detection and supervisory circuits, minimum #12 power supply). All fire alarm system wiring shall be provided with a separate insulated ground conductor sized in accordance with Electrical Safety Code regulations.

.2 All wiring for detection zones shall be installed as Class 'A' type obtained by wiring in a loop method around zone area such that wiring pairs (feed and return) are not installed in the same conduit and conduits are not run together.

.3 All other wiring shall be standard Class 'B' type.

.4 Install all wiring in a separate conduit system in accordance with this specification and Electrical Safety Code requirements complete with recessed device boxes for approved component mounting.

.5 Use fire rated pyrotenax mineral insulated cable as noted and/or required to meet Building Code regulations. For multiplex communication wiring to remote annunciator and transponders, use twisted shielded pair wiring in accordance with manufacturer's specifications.

.6 Connect sprinkler system flow switches (by Division 21) to the system to indicate an alarm condition on the appropriate zone. Connect standpipe/sprinkler system tamper switches (by Division 21) to the system to indicate a trouble condition on the appropriate zone. Connect fire pump monitor contacts to the system to indicate a trouble condition on the appropriate zone.

.7 Connect auxiliary control circuits to the system to provide proper equipment operation. Provide in-line fuse protection at control panel for all auxiliary control circuits.

.8 Wiring connections shall be made as shown on drawings furnished by the manufacturer. Power shall not be applied to the system until the representative of the manufacturer has approved the connections to the control equipment.

.9 Wiring requirements for shielding certain conductors from others or routing in a separate raceway shall be as recommended by the manufacturer's documentation and included in the bid.

.10 Provide all new system wiring to comply with the new system circuit zoning, devices and wiring requirements.

3.3 INSTALLATION

.1 Mounting heights of equipment shall be as follows:

.1 Manual Stations – 1150 mm (46”) to centre of back box. New stations installed at existing locations shall be re-positioned to new mounting height.

.2 Audible Signals - 2400 mm (8’-0”) or 300 mm (12”) below ceiling, to centre of device, whichever is lower.

.3 Visual Signals – 2400 mm (8’-0”) to top of lens.

.4 Panels - 2000 mm (6’-8”) to top of trim.

.5 End of line resistors - 1800 mm (6’) to centre of device.

.2 Locate detectors as shown considering spacing and mounting requirements contained in CAN/ULC-S524. Locate detectors away from radiating surfaces or positions affected by ventilation grilles.

.3 End-of-line resistors will be furnished as required for mounting as directed by the manufacturer. These devices are not shown on plans but shall be located in public spaces.

.4 Connect sprinkler system flow and alarm switches, by Division 21 Fire Suppression, to the fire alarm system to indicate an alarm condition on the appropriate zone. Connect standpipe/sprinkler system pressure and tamper switches, by Division 21 Fire Suppression, to the system to indicate a trouble condition on the appropriate zone. Connect fire pump power supply auxiliary monitor contacts to the system to indicate a trouble condition on the appropriate zone.

.5 Connect supervisory device contacts to the system to indicate a trouble condition on the appropriate supervisory zone. Connect auxiliary control circuits to the system to provide proper equipment operation. Provide in-line fuse protection at control panel for all auxiliary control circuits.

.6 Wiring connections shall be made as shown on Drawings furnished by the manufacturer. Power shall not be applied to the system until the representative of the manufacturer has approved the connections to the control equipment.

.7 Connect auxiliary control circuits to the system to provide proper equipment operation. Provide in-line fuse protection at control panel for all auxiliary control circuits.

3.4 FIELD QUALITY CONTROL

.1 The manufacturer shall make a complete inspection of all installed fire alarm equipment including each and every component such as manual pull stations, signal bells, automatic thermal and smoke detectors, annunciation and control equipment, etc. in accordance with CAN/ULC-S537 to ensure the following:

.1 That the system is complete and in accordance with the specifications.

.2 That the system is connected according to U.L.C. requirements.

.3 That the system is installed in accordance with the manufacturer's recommendations.

.4 That the regulations concerning the supervision of components have been adhered.

.2 Any subsequent changes to conform to the above shall be done with technical advice supplied by the manufacturer.

.3 All fire alarm system testing and verification shall use only safe, non-damaging test methods in accordance with CAN/ULC-S536. Open flame or smoke shall not be used for any on-site testing of detection devices for proper operation.

.4 During the period of inspection, this <Contractor/Sub-Contractors shall supply to the manufacturer all personnel necessary to complete the inspection and also supply any required equipment such as ladders, scaffolding, etc.

.5 On completion of the inspection the manufacturer shall supply the Consultant with a certificate together with detailed inspection record sheets, confirming that the system is installed in accordance with the above outlined requirements. He shall also confirm in writing that all authorized building personnel have bee instructed as to system operation and maintenance procedures etc.

.6 All costs involved in this inspection both from the manufacturer and this Section's work, will be included with the total tender price.

.7 Provide a four (4) hour familiarization, training and instruction session as required, for the Owner's maintenance staff to review the working and function of the system and equipment; and to instruct personnel about proper maintenance.

.8 It shall be the responsibility of the installing contractor to assure that construction debris does not adversely affect any sensing devices installed as part of this project. Should it be deemed necessary by the Consulting Engineer, End-User, or AHJ, the installing contractor shall be responsible for the cleaning of all smoke detectors prior to final acceptance.

3.1 THIRD-PARTY VERIFICATION

.1 Verification shall be carried out in accordance to CAN/ULC-S537 Verification of Fire Alarm Systems. The Third-party verifier shall provide a Verification Certificate and Verification Report to show compliance with CAN/ULC-S537 Verification of Fire Alarm Systems.

.2 Verification must be carried out by an agency (or individual) acceptable to the Authority Having Jurisdiction, who can demonstrate they have the sufficient training or experience, and who is not the installing contractor, fire alarm manufacturer, or involved in the design or installation of the fire alarm system.

.3 All fire alarm system testing and verification will use only safe, non-damaging test methods in accordance with CAN/ULC-S536. Open flame or smoke will not be used for any on-site testing of detection devices for proper operation.

3.2 AUDIBILITY TESTING

.1 All rooms within the scope of work shall be tested with a professional sound level meter that has an accuracy of ± 1.5 dB. Sound level meter used in testing shall be the same for all areas of the building for both with alarm and without. Tester will be calibrated immediately before and after the audibility measurements are taken based on ANSI S1.40, Specifications for Acoustical Calibrators.

.2 Sound level measurements shall be taken in accordance to CAN/ULC-524 Appendix C - Sound Level Measurements with the following additional requirements.

.1 Tester will perform all tests with all doors and windows closed and when unusual noises are not present.

.2 Tester will perform test to get ambient noise level without alarm to measure ambient sound level and perform the test again with the with alarm to measure alarm sound level.

.3 All test results should be tabulated showing the following columns: room number/name, building code minimum sound level, ambient noise level, and alarm noise level

3.3 FIREWATCH

.1 If during the course of construction, the fire alarm system or zones within the building are required to be fully or partially shut down for any period of time, provide a Firewatch for all the affected areas in accordance with the Fire Code during that time period. This Firewatch should be in place for the entire duration of the shutdown.

3.4 SEQUENCE OF OPERATION

.1 The fire alarm system shall function such that the activation of any detection circuit (automatic detector, manual station, sprinkler flow switch) will result in the following system operation:

.1 Activate the control panel to cause general alarm signal to be produced by all signal devices throughout the building.

.1 All audible appliances shall be synchronized with each other when two or more signalling devices can be heard. Audible devices shall have the ability to be silenced.
.2 Strobes shall be synchronized with each other in any location with two or more strobes in a common field of view. Visual devices shall be non-silenced unless the system is successfully reset.

.2 Indicate alarm origin on control panel display and at the remote annunciators.

.3 Cause recirculating air fan systems to shut down. Cause other controlled equipment to shut down.

.4 Transmit signal to central monitoring station/municipal fire department (per ULC-S561).

.5 Transmit signal to return all elevators that serve the floor of alarm initiation to the ground floor. If the alarm originates from the ground floor, return all elevators to the floor above or to a level as directed by the local fire department

.6 Cause electrically connected or hold open doors to close and release lock on electrically latched exit doors throughout the building.

.2 Alarm signals shall sound continuously (unless manually reset) for not less than 20 minutes at which time the audible signals shall automatically silence (TLC), but the visual alarm signal shall remain or until the alarm condition is reset to normal.

.3 It shall not be possible to silence the alarm signals or reset the panel during the first minute of alarm. (Inhibit)

.4 The auxiliary circuit connections shall provide automatic operation of auxiliary equipment with manual override on a circuit basis provided by panel control switches. Control circuit operation shall be software programmable to perform functions in sequence or on the basis of specific input circuit status.

.5 The entire fire alarm system shall be electrically supervised such that the trouble signals shall operate until the trouble condition is corrected but shall not cause a false alarm. A trouble signal shall be transmitted upon loss of primary power, activation of a supervisory circuit (valve tamper switch), or any opens, grounds or disarrangement of system wiring and shots across alarm signaling wiring detection of a circuit fault on any circuit. A trouble signal shall not interfere with the transmission of an alarm signal. A trouble condition on one zone shall not affect operation of the remaining zones.

.6 The system shall identify any off normal condition and log each condition into the system database as an event.

.1 The system shall automatically display on the control panel LCD the first event of the highest priority by type. The priorities and types shall be alarm, supervisory, trouble, and monitor.

.2 The system shall have a Queue operation, and shall not require event acknowledgment by the system operator. The system shall have a labeled color-coded indicator for each type of event; alarm - red, supervisory - yellow, trouble - yellow, monitor - yellow. When an unseen event exists for a given type, the indicator shall be lit.

.3 For each event, the display shall include the current time, the total number of events, the type of event, the time the event occurred and custom user description.

.4 The user shall be able to review each event by scrolling (up-down) for each event type.

.5 Upon acknowledging or silencing any event at the control panel, any new alarm, supervisory, or trouble events shall re-sound at the control panel.

.7 Smoke and heat detector devices in elevator lobby, shaft, and machine room will comply with sequences and operation of local, provincial, TSSA, and CSA B44.1 requirements for main/alternate floor recalls and shunt trip activations.

END OF SECTION