Brock University
Scotia Bank Hall Renovation

Brock Project No: DB25-03
aTRR Project No. 2615-24

Technical Specifications
MECHANICAL + ELECTRICAL
ISSUED FOR TENDER

21 March 2025

Chorley+Bisset
CONSULTING ENGINEERS

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BROCK UNIVERSITY

SCOTIA BANK HALL RENOVATION

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CHORLEY + BISSET LTD
CONSULTING ENGINEERS
LONDON ONTARIO

FILE NO. 10348
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No. of Pages

Mechanical Specifications

Electrical Specifications

1 General

1.1 GENERAL REQUIREMENTS

1.1.1 This Section and Division 01 apply to and govern the work of all Sections of Divisions 21, 22, 23 and 25.

1.2 VISITING SITE

1.2.1 Visit the site and be familiar with working conditions and work involved before submitting Bids. No extras will be granted due to lack of a thorough preliminary investigation of the site.

1.2.2 Where applicable, remove and replace existing ceiling tile to inspect ceiling space for existing Mechanical, Electrical and Structural obstructions. Include cost of all necessary changes in Bid Price. No extras will be granted due to lack of a thorough preliminary investigation of accessible ceiling spaces.

1.2.3 For renovation projects, Contractors visiting for site investigation must sign in at the facility's main office and register with facility staff. Where required by the Owner, review and sign any on-site Designated Substances Reports prior to site investigation in any area potentially containing Designated Substances or Hazardous Materials.

1.3 CONTRACT DRAWINGS

1.3.1 Mechanical Drawings show Mechanical work only and are not intended to show Structural details, Electrical details, or Architectural features. Take building dimensions and details from Architectural or Structural Drawings or from job measurements. Any dimensions shown on Drawings are approximate. Verify dimensions by reference to Shop Drawings and field measurement.

1.3.2 Only the general location and route of piping and ductwork is shown. Install all piping and ductwork neatly to conserve headroom. All piping and ductwork to be installed parallel to building lines unless shown otherwise.

1.3.3 The Consultant reserves the right to revise the locations of equipment and outlets within any given room without altering the Contract Price provided Notice of Change is given prior to roughing-in.

1.3.4 In case of conflict between work of other trades and work of these Divisions, clarify the location of these items with the Consultant before roughing-in.

1.3.5 In the event of any discrepancies or ambiguity of any symbol, note, abbreviation, etc., used in this Specification or on the Contract Drawings, obtain clarification, in writing, from the Consultant prior to submitting Bid. No allowance will be made for additional costs arising from failure to obtain proper clarification of conflicting information before Bid.

1.3.6 Quantities or lengths indicated in any of the Contract Documents are approximate only and will not be held to gauge or limit the work. No adjustment to the Contract Price will be allowed to complete the work.

1.3.7 Verify equipment access and coordinate with equipment supplier to ensure equipment can be physically transported to installation location. Under no circumstances will any claim be allowed for extra cost to disassemble and/or assemble equipment at the final location which will be considered as part of equipment installation.

1.3.8 Provide labour, products, and services specified, but not shown on Drawings and vice versa, and all other labour, products, and services necessary for completion of the work.

1.3.9 Where dimensions and sizes are presented in the documents in SI units, generally, units are in millimetres. All exceptions to this are noted. Pipe sizes are in accordance with ANSI Standards.

1.4 SHOP DRAWINGS

1.4.1 Submit manufacturers' Shop Drawings, electrical wiring diagrams and control system drawings to the Consultant for review, prior to ordering any equipment or devices. Prior to submission of any Shop Drawings, provide a complete list of Shop Drawings to be submitted, in Microsoft Excel format. List all Shop Drawings, as well as approximate date of submission.

1.4.2 Provide title sheet for each Shop Drawing submitted. Include project name, Shop Drawing item (including Specification paragraph and subparagraph reference) and Contractor and Subcontractor approval stamps. The Consultant reserves the right to have samples submitted of any specified products.

1.4.3 Submit all Shop Drawings electronically in PDF format. Email, file transfers and file links will be accepted. If multiple items are submitted in a single PDF file, Shop Drawings must be from the same Specification Section and each individual piece of equipment, report, document, etc, must be bookmarked, using equipment labels as per Design Drawings. Do not submit compressed files.

1.4.4 Catalogues, manuals, or price lists will not be accepted as Shop Drawings. Before submission, review and check Shop Drawings, make necessary corrections, apply stamp “Reviewed and Certified Correct”, sign and date. The Contractor is to document any differences between the Shop Drawing submission and the description listed in the Specification. If there are no differences listed, the Contractor implicitly declares the Shop Drawing meets all requirements of the Specification.

1.4.5 The review of Shop Drawings by Chorley + Bisset Ltd. is for the sole purpose of ascertaining conformance with the general design concept. This review does not mean that Chorley + Bisset Ltd. approves the detail design inherent in the Shop Drawings, responsibility for which remains with the Contractor. Such review does 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 Construction and 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 subtrades.

1.4.6 Ensure at least one copy of the reviewed Shop Drawings is kept on site at all times for reference.

1.4.7 Shop Drawings are to be prepared and presented in either SI or IP units, as required to match the units presented on the Drawings. Shop Drawings that include both SI and IP units will also be accepted.

1.5 **FIELD DRAWINGS**

1.5.1 Submit, to the General Contractor, Drawings accurately showing all openings for ducts, pipes, etc. Drawings must include the size of openings and their locations by dimensions, including the location of the structural members framing these openings. Each trade will be responsible for detail layout of their own work.

1.5.2 Assume full responsibility for the detailed coordination of all Mechanical Trades work. Prepare Field Drawings to determine the exact location of each service. On these Drawings, include all mechanical and electrical services, architectural features, and structural details. If a conflict becomes apparent after the installation of services, pay all costs associated with removing and reinstalling these services.

1.5.3 For Buildings equipped with Sprinkler Systems, if the General Contractor separates the Fire Protection Sprinkler System work from the other work of Mechanical Trades, the General Contractor assumes full responsibility for this coordination work, including the preparation of the Field Drawings.

1.6 AS-BUILT DRAWINGS

1.6.1 General

1.6.1.1 The Contractor will be provided with Mechanical Drawing files used to produce the contract documents. The following digital formats were used and are to be maintained: PDF, AutoCAD and/or Revit. The Contractor is to print Drawings from the PDF files provided. A waiver will need to be signed by the Contractor before the Revit model will be transmitted.

1.6.2 Transfer of As-Built Information to Electronic Format

1.6.2.1 Revise and maintain the prints as work progresses. Show all revisions, relocations, and changes, to scale. Use colour markings. At the end of the project, provide a complete PDF redline mark-up set of As-Built Drawings to the Consultant, for record purposes. Printed hard copies will not be accepted.

1.6.2.2 For the purposes of Contract payments, the PDF redline mark-up set of As-Built Drawing files will be assumed to have a value of $2,500.00. This will not be released until As-Built Drawing files have been accepted as complete and acceptable by the Consultant. This amount is in addition to the normal 10% holdback required by the Construction Lien Act, 2018.

1.6.2.3 Refer to cash allowances Section of Division 01 Specifications. Where a cash allowance is included for the Consultant to transfer As-Built information to the AutoCAD files and/or Revit model, the Consultant will transfer As-Built information from the PDF redline mark-up set of As-Built Drawings to AutoCAD files and/or the Revit model.

1.6.2.4 If a cash allowance is not included in the Division 01 Specifications for the Consultant to transfer As-Built information the AutoCAD files and/or Revit model, the contractor will be responsible for doing so, in accordance with the instructions below.

1.6.3 Electronic As-Built Deliverables

1.6.3.1 Transfer information from the marked prints to AutoCAD and/or Revit files on a monthly basis to match the software version the original files were created in. Have the marked prints and updated AutoCAD and/or Revit prints on site for review by the Consultant at all times. Monthly draws will not be approved unless all changes have been shown.

1.6.3.2 Prior to testing, balancing and final commissioning, complete the transfer of marked prints to the AutoCAD and/or Revit files. Fill in the Owner’s equipment numbering system in the Schedules on the Drawings and on the plans wherever blank placeholder tags have been shown.

1.6.3.3 AutoCAD and/or Revit files are to match exactly the layering system, format, and symbology of the Consultant. Bind all external references.

1.6.3.4 Mark Drawings with As-Built stamp, update revision column, and insert name and logo of Contractor. Submit one set of printed As-Built Drawings for review by the Consultant. Remove Engineer's Stamp.

1.6.3.5 Submit completed As-Built Drawings on USB memory sticks, DVDs, or electronic transfer, in the same digital data software program and version as original contract documents. Also provide one set of As-Built Drawings with the Operating and Maintenance Manuals.

1.6.3.6 For the purposes of Contract payments, electronic As-Built Drawing files will be assumed to have a value of $2,500.00. This will not be released until As-Built Drawing files have been accepted as complete and acceptable by the Consultant. This amount is in addition to the normal 10% holdback required by the Construction Lien Act, 2018.

1.6.4 **Revit/Bim Deliverable (Where Applicable)**

1.6.4.1 As-Built updates to the Revit model are to be completed in accordance with the project Revit/BIM deliverable. If no deliverable is defined, the minimum deliverable requirement is that the Sheets included under the "02-Construction" subset in the model properly display the As-Built condition. Bind/Insert all linked files in the Revit model.

1.6.4.2 Model developed by the Consultant will not include engineering, analytics, or systems symmetry functionality (i.e. defined or totally connected systems).

1.6.4.3 All engineering and manufacturer information contained in the model will only be considered accurate for identification purposes, with regard to the corresponding Specifications and drawing schedules. The Contractor is not to rely on any engineering, dimensional or other manufacturer information contained in the model.

1.6.4.4 Mechanical, electrical, plumbing, and sprinkler system components should be modelled by the Contractor to be as close as possible to As-Built conditions, but must still produce an acceptable and legible printed As-Built document.

1.6.4.5 The Sheets included under the "02-Construction" subset in the model should properly display the As-Built condition.

1.6.4.6 Mechanical, electrical, plumbing, and sprinkler system components in the model (i.e. piping, conduit) may not be modelled the proper size, but will be identified correctly.

1.6.4.7 Mechanical, electrical, plumbing, and sprinkler system components in the model will be represented properly on floor plans (i.e. symbology) but not necessarily in elevations.

1.6.4.8 Mechanical, electrical, plumbing, and sprinkler equipment and other items that are generally required for coordination among disciplines (i.e. ceiling components) will be included in the model (approximate size shown). Many services will be shown in schematic fashion (i.e., not necessarily at correct elevation or in exact position required).

1.6.4.9 Due to the schematic nature of many portions of the model, services are likely to conflict and clash with various other services and structure. In some cases this is intentional, so that services display properly and legibly on Sheets.

1.6.4.10 The Consultant will not be responsible for providing to the Contractor a detailed, accurate, or clash free model without additional compensation, as the Owner has not required or paid for this work to be done by the Consultant. In turn, the Consultant will not require the Contractor to provide a more detailed, accurate, or clash free model for the project As-Built documentation, than was originally provided to the Contractor.

1.6.4.11 Responsibility for creation of accurate Field Drawings and resolving interferences, conflicts and clashes between services, structure, etc, remains with the Contractor.

1.7 CONFLICTS AND PRECEDENCE

1.7.1 Immediately upon discovery of any conflict, ambiguity, error, or omission in the Contract Documents, request clarification in writing from Consultant prior to starting the work in questions.

1.7.2 Failure to give such written notice will constitute an irrevocable waiver and release of any claim for additional compensation or delays incurred.

1.7.3 Where work fails to conform to Contract Documents, as clarified by Consultant, promptly remove and replace such work as directed, without adjustment to Contract Price.

1.8 FIRESTOPPING

1.8.1 Before starting any work on site, submit detailed Shop Drawings to the Consultant for review and comments. Include:

1.8.1.1 Manufacturer’s technical product data and installation instructions for each specific type and location of penetration.

1.8.1.2 Certification that proposed firestopping materials and assemblies comply with latest version of CAN-ULC S115 “Standard Method of Fire Test for Firestop Systems”.

1.8.1.3 For each specific type and location of penetration, provide installation instructions from a recognized independent testing agency.

1.8.2 Mark penetration and system number types and locations on set of white prints. At completion of project, transfer this information to As-Built Drawings.

1.8.3 Comply with all requirements of Ontario Building Code Clause 3.1.9, “Building Services in Fire Separations and Fire Rated Assemblies”.

1.9 MAINTENANCE AND OPERATING INSTRUCTIONS

1.9.1 General

1.9.1.1 Assemble and provide Maintenance and Operating Instruction Manuals for the Owner, that are comprehensive and adequate to inform Owner of all maintenance and operating activities required for the project equipment and systems.

1.9.1.2 Submit manuals to Consultant for review and approval, prior to submittal to Owner. Make changes or submit additional information as required to obtain approval. Final Certificate of Completion will not be issued until Manuals have been approved by the Consultant and provided to the Owner or Consultant.

1.9.2 Manual Content

1.9.2.1 Maintenance and Operating Instruction Manuals are to include equipment literature (data sheets), installation instructions, operating instructions, maintenance instructions, pressure test results, certificates, other pertinent data, as well as Contractor’s Letter of Warranty. Include copies of approved Shop Drawings and name and address of Spare Parts’ Suppliers with manuals.

1.9.2.2 Divide the maintenance manuals into Sections, including both a General Section at the start of the manual, and remaining Sections which correspond with Specification Sections.

1.9.2.3 The following information is to be contained within the General Section: a comprehensive list of names, addresses and telephone numbers of the Consultants, General Contractor, Mechanical Contractor, and all mechanical subcontractors. Include the Mechanical Contractor’s Letter of Warranty for the Mechanical systems. Include a copy of all equipment extended warranties. Include a copy of the valve directory, which shows the valve number, location, normal valve position, and the purpose of the valve. Include a copy of all natural gas fitter’s tags for natural gas systems. Include a copy of owner’s

asset tag information form for all equipment.

1.9.2.4 Each Section corresponding to a Specification Section is to include, as applicable, a list of names, addresses and telephone numbers of all suppliers, as well as a copy of all approved Shop Drawings for that Section. Include a copy of all pressure tests and operational tests for piping systems, leakage tests for duct systems, and startup reports for all equipment. Include all equipment warranties. Include a copy of report data for degreasing and flushing of heating, cooling and other piping systems, analysis of system water taken at time system was put into operation, hydrostatic or air tests performed on piping systems, equipment alignment certificates, valve tag identification, and pipe colour code chart. Include a complete list of all air filter sizes, quantities, and types, corresponding with unit designations. Include Testing and Balancing Report.

1.9.2.4.1 In each Section, provide a preventive maintenance schedule for each of the major components and equipment items. Include daily, weekly, monthly, semi-annual, and yearly checks and tasks. Include this information as a separate preventive maintenance schedule. Copies of manufacturer's Shop Drawings will not be accepted as the required preventive maintenance schedule. Provide lubrication information and instructions which will explain the varied bearings and lubrication procedures.

1.9.2.4.2 Controls Section is to include all items listed above, as well as complete As-Built control diagrams and drawings, wiring diagrams, points lists, final control sequences, descriptions of system functions and all commissioning, checkout and test reports.

1.9.3 **Manual Formats**

1.9.3.1 Refer to Division 01 Specifications for Operating and Maintenance Manuals required quantities and formats. If not specified in Division 01, provide three hardcopy sets of manuals and one electronic format set.

1.9.3.2 Include As-Built Drawing sets with the Operating and Maintenance Manuals, in matching format required by Owner (i.e. quantities of soft and hard copies matching manuals). Where hardcopies are provided, As-Built Drawing sets are to be printed and neatly bound.

1.9.3.3 Electronic manuals are to be prepared in PDF format. Manual to be provided as one file formatted with bookmarks, in accordance with the Sections of the hard copy manuals. Do not include separate files in sub folders. Submission is to be either on a USB Drive or through electronic transfer, in accordance with Owner's preference.

1.9.3.4 Where required, hardcopies of Maintenance and Operating Instruction Manuals are to be placed in three ring binders, complete with index pages, indexing tabs and cover identification at front and side.

1.10 REGULATIONS AND PERMITS

1.10.1 Carry out all work in accordance with the latest editions of applicable municipal and provincial codes, regulations, bylaws, and requirements of local Authority Having Jurisdiction. In no instance, however, is the standard established by the Drawings and Specifications to be reduced by the codes referred to above. Apply for and obtain any necessary permits. Pay any necessary fees.

1.10.2 Enforce all prevailing Provincial and local safety regulations at all times. Abide by all Owner's safety and security policies and procedures and conform to all regulations of the current Occupational Health and Safety Act.

1.10.3 Fill out TSSA forms and pay all costs associated with removal of existing equipment, wherever equipment is currently registered with TSSA.

1.10.4 Arrange and pay for TSSA inspection and certification for all piping systems and equipment regulated by TSSA.

1.11 MATERIAL AND EQUIPMENT

1.11.1 Where an item of material or any equipment is specifically identified by a manufacturer's trade name and/or catalogue number, make no substitution except as provided for in paragraphs 3, 4 and 5 below.

1.11.2 In the case of some items of equipment, one or more additional names of acceptable equal manufacturers are listed in the Clause describing an item or a group of items. The design, layout, space allocation, connection details, etc., are based on the products named first in the description of each item. The products named first in the description of each item establish the quality of manufacture and design standards for all other manufacturers of that item. The general approval indicated by listing the names of other manufacturers is subject to final review of Shop Drawings, performance data, test reports, production samples (if required) by Consultant, and equipment shipped to site. Ensure that the products used meet the requirements specified and as shown on the Contract Drawings.

1.11.3 Suppliers wishing to submit other items of equipment for approval as an equal to those specified must apply to the Consultant at least 8 working days before Bid closing date. Requests must be accompanied by complete description and technical data on the items proposed. Approval for substitution of equipment will only be given on the understanding that all details, accessories, features, and performance meet the Specifications unless otherwise stated. Deviations from the Specifications must be stated in writing at time of application for approval.

1.11.4 Include in the Bid, the equipment named in the Specifications or approved as an equal as in paragraph 3 above. This will form the Base Bid. Any number of alternative bids, as defined below, may be included in addition to the Base Bid.

1.11.5 Items of equipment by Manufacturers not named in the Specifications may be offered as alternatives to the manufacturers named in the Specifications. The alternative proposals must be accompanied by full descriptive and technical data, together with the statement of amount of addition or deduction from the Base Bid, if the alternative is accepted. Prior approval by the Consultant is not required on items submitted as alternative bids.

1.11.6 After execution of the Contract, substitution of equipment will be considered only if equipment accepted cannot be delivered in time to complete the work in proper sequence, or if the manufacturer has stopped production of the accepted item. In such cases, requests for substitution must be accompanied by proof of equality and difference in price and delivery, in the form of Certified Quotations from Suppliers of both specified and proposed equipment. Credit any decrease in price involved in substitution to the Owner by reduction of the Contract Price. The Contractor will not be reimbursed for any such increase in price.

1.11.7 Where equipment other than the equipment used as a basis for design, layout and space allocation is used, produce and submit revised layouts of equipment, pipes, ducts, etc., in the areas affected. Submit these Drawings with the Shop Drawings. Failure to produce these Drawings is indication by the Contractor that they are not required and the original space allocations are adequate for the substituted equipment.

1.11.8 Name the Subcontractors and Manufacturers in the Bid as indicated in Clause “List of Mechanical Subcontractors and Manufacturers”.

1.12 **INTERPRETATION OF CONTRACT DOCUMENTS**

1.12.1 The decision as to which trade provides required labour or materials rests solely with the Contractor. Extra payments will not be considered based on a difference in interpretation of the Contract Documents as to which trade involved provides materials or labour for specific items of work. The Consultant will not enter into such discussions.

1.13 **SITE VISITS**

1.13.1 The Mechanical Contractor shall have an office representative (not site personnel) at each site meeting and deficiency review. Attendance at these meetings is mandatory.

1.14 **PROGRESS DRAWS**

1.14.1 Mechanical Contractor shall review all supplier and subcontractor draws submitted to their office to ensure they are fair and reasonable for the amount of work completed on site to date prior to submitting to the General Contractor. Mechanical Contractor will be responsible for the validity of supplier and subcontractor draw claims.

1.15 **WARRANTY**

1.15.1 Warranty all workmanship and make good any defects for one year after Ready for Takeover except where specified otherwise. Warranty material and equipment supplied by the manufacturers for one year after Ready for Takeover. Make good damage caused due to defects and workmanship.

1.15.2 Where equipment specified in Sections of Divisions 21, 22, 23 and 25 to have an extended warranty period, e.g. five years, the first year of the warranty period will be governed by the terms and conditions of the warranty in the Contract Documents, and the remaining years of the warranty will be direct from the manufacturer and/or supplier to the Owner. Submit signed and dated copies of the extended warranties to the Consultant before applying for a Certificate of Substantial Performance of the Work.

2 Products

2.1 **MATERIALS**

2.1.1 Use materials specified herein or approved equal as defined in Clause “Material and Equipment”.

2.2 PIPING

2.2.1 Supports and Hangers

2.2.1.1 Use Anvil beam clamps.

2.2.1.2 For horizontal piping 32 mm (1-1/4") and less, use line size adjustable wrought steel clevis type hangers. For copper pipe, wrap pipe with tape at all hangers or use Anvil Figure CT-99C adjustable tubing ring hangers.

2.2.1.3 For piping 40 mm (1-1/2") and larger, use adjustable wrought steel clevis type hangers large enough for pipe insulation. See Section 22 07 00 for insulation shields.

2.2.1.4 For boiler feedwater and condensate and steam piping 75 mm (3") and larger, use adjustable roller hangers (Anvil Fig 181) or base-mounted pipe rollers (Anvil Fig 274). Use steel pipe covering protection saddle for each location.

2.2.1.5 The following manufacturers of the above equipment will be considered equal subject to requirements of Clause “Material and Equipment”:

Anvil
Taylor Pipe Supports

2.2.2 Provision for Expansion

2.2.2.1 Provide pipe guides in accordance with “Standards of the Expansion Joint Manufacturers Association, Inc.”.

2.2.2.2 The following manufacturers of the above equipment will be considered equal subject to requirements of Clause “Material and Equipment”:

Anvil
Flexonics
Flex-Pressions

2.3 CONCRETE

2.3.1 Use concrete in accordance with the requirements of General Trades Specification Sections, unless specified or shown otherwise.

2.4 SLEEVES

2.4.1 In general, sleeves are not required through walls or floors except for penetrations through Service Room walls or floors, foundation walls, or for steam and condensate piping system wall or floor penetrations.

2.4.2 For rated separation requiring a FT firestopping rating, use materials in conformance with manufacturer's recommendations.

2.5 FIRESTOPPING

2.5.1 Use only service penetration firestop components and assemblies tested in accordance with latest version of CAN/ULC S115 Fire Tests of Firestop Systems and listed in most recent ULC "List of Equipment and Materials" or by another recognized independent testing and certification agency acceptable to the Consultant.

2.5.2 All pipe insulation passing through the fire separation to be approved with the listing of the firestop system.

2.5.3 Fire stopping installers must be trained by the fire stopping manufacturer and be able to provide proof of training by providing Fit Level 1 certificate when requested, while working on site.

2.5.4 Pipe sleeves through fire separations requiring a rating are to be installed as per firestopping manufacturer's recommendations, as some firestopping manufacturers do not allow pipe sleeves within their approved system. Confirm pipe sleeve compatibility prior to starting work on site.

2.5.5 The following manufacturers of the above equipment will be considered equal subject to requirements of Clause "Material and Equipment":

STI

2.6 FIRE RATED FOAM SEALANT

2.6.1 Use ULC Classified fire rated foam sealants.

2.6.2 The following manufacturers of the above equipment will be considered equal subject to requirements of Clause "Material and Equipment":

3M Fire Barrier
Metacaulk
Dow Fire Stop

2.7 FIRE CLOSURES

2.7.1 Use only fire damper assemblies tested in accordance with CAN/ULC S115 Fire Tests of Firestop Systems and listed in most recent ULC "List of Equipment and Materials" or by another recognized independent testing and certification agency acceptable to the Consultant.

2.8 ESCUTCHEON PLATES

2.8.1 Provide one piece brushed aluminum escutcheon plates at all points where pipes pass into finished areas through walls, floors, or ceilings.

2.9 ACCESS DOORS

2.9.1 Access doors to be flush to edge of frame, concealed continuous hinge with screwdriver operated cam latch. Non fire-rated door construction to be minimum 14 gauge, with 16 gauge frame. Fire-rated door construction to be a minimum 20 gauge insulated door with 16 gauge frame. Insulation thickness to provide required rating.

2.9.2 Size doors to allow adequate operating/maintenance clearance for devices. Doors to be a minimum 600 mm x 600 mm (24" x 24") for body entry, and 300 mm x 300 mm (12" x 12") for hand entry, unless noted otherwise. Use the following access doors:

Masonry Walls	Acudor UF-5000
Drywall Walls and Ceilings	Acudor DW-5040
Fire-Rated	Acudor FW-5050/FB-5060 to match fire separation
All Other Locations	Acudor UF-5000 (stainless)

2.9.3 The following manufacturers of the above equipment will be considered equal subject to requirements of Clause “Material and Equipment”:

Cendrex
Elmdor

2.10 ELECTRICAL EQUIPMENT

2.10.1 In buildings equipped with automatic sprinkler systems, use sprinkler proof electrical equipment. Where electrical equipment provided by Mechanical Trades is not of sprinkler proof design, fabricate and provide galvanized steel shields and hoods to prevent sprinkler system water from entering the electrical equipment and/or interfering with its operation.

2.11 ELECTRIC MOTORS

2.11.1 Provide motors of adequate size and type for intended service. Use CSA approved motors with the following characteristics:

250 watts (1/3 hp) and under - 115 volt, 60 hertz, single phase.
370 watts (1/2 hp) and over - 60 hertz, three phase, voltage as shown on Drawings.

2.11.2 Motors are to be the voltage specified. Step down or step up transformers will not be accepted.

2.11.3 Motors 250 watts (1/3 hp) and under: Use continuously rated squirrel cage induction type with capacitor start, NEMA Design Class B with NEMA Class N or better starting characteristics and a minimum of Class B insulation, unless specified otherwise.

2.11.4 Motors 370 watts (1/2 hp) and over: Use continuously rated squirrel cage induction type, NEMA Design Class B with NEMA Class B or better starting characteristics and a minimum of Class B insulation. Where motor is installed in an area that could see higher ambient temperatures, higher insulation class will be required. Use a minimum of Class F insulation for 41°C to 65°C (106°F to 149°F) ambient temperature and a minimum of Class H insulation for 66°C to 90°C (150°F to 194°F) ambient temperature.

2.11.5 Use open drip-proof type motor with a 1.15 service factor for motors located in dry locations indoors, unless specified or required otherwise by the motor location.

2.11.6 Use totally enclosed motors outdoors and in locations subject to water spray. Totally enclosed motors must be fan cooled and have a 1.0 service factor.

2.11.7 Use totally enclosed explosion-proof (TEXP) motors where indicated to prevent ignition of external gas.

2.11.8 All enclosures shall be rolled steel band or cast iron construction. Motor nameplate shall be mounted on enclosure with stainless steel fastening pins and shall have, as a minimum, all information as described in CSA C22.2 No 100-04 (R2009).

2.11.9 Unless specified otherwise, starters for electric motors will be provided by Division 26. Where multi-speed motors are specified, ensure that motors are compatible with starters supplied under Division 26.

2.11.10 All two speed motors to be single winding, unless specified otherwise. Provide inverter duty motors where indicated on Drawings.

2.11.11 All motors 0.75 kW (1 hp) and above, use premium efficiency type motors in accordance with NEMA Premium efficiency standard.

2.12 ELECTRICAL WIRING

2.12.1 Meet all requirements of Division 26 for all wiring included in Division 21, 22, 23 and 25 and pre-wired equipment provided by Division 21, 22, 23 and 25.

2.12.2 Ensure all pre-wired electrical equipment is CSA approved. Where this is not possible, arrange and pay for special Electrical Safety Authority approval.

2.12.3 All electrical wiring, both line voltage and low voltage, for equipment supplied by Division 21, 22, 23 and 25 is the responsibility of Division 21, 22, 23 and 25. Line voltage wiring from power panels to starters and from starters to motors will be supplied and installed by Division 26.

2.13 IDENTIFICATION NAME LABELS

2.13.1 Identification name labels, directional arrows, and colour bands for ductwork and piping to be plastic coated pressure sensitive “Brady” or “Westline” selfstick labels, waterproof, colourfast, dirt and grease resistant. For pipes up to and including 65 mm (2-1/2") diameter, use markers 28 mm (1-1/8") high. For pipes 75 mm (3") diameter and over, and all ductwork, use markers 57 mm (2-1/4") high. For all piping exposed to view, use Smillie McAdams Summerlin Coil - Mark pipe covers.

2.13.2 The following manufacturers of the above equipment will be considered equal subject to requirements of Clause “Material and Equipment”:

Visionmarker

2.14 VALVE AND CONTROLLER TAGS

2.14.1 Use brass valve and controller tags with 32 mm (1-1/4") stamped code lettering and numbers filled with black paint. Hang a copy of the valve chart in Mechanical Room.

2.15 EQUIPMENT NAMEPLATES

2.15.1 Use minimum size 90 mm x 40 mm x 2.4 mm (3-1/2" x 1-1/2" x 3/32") thick laminated phenolic plastic nameplates with black face and white lettering. Lettering to be minimum 6 mm (1/4") high.

2.16 FLASHING

2.16.1 For locations with multiple roof penetrations serving equipment, such as for roof mounted, split system condensing units, use Portals Plus, Inc. Alumi-Flash system consisting of 330 mm (13") high, one piece spun aluminum base with deck flange and EPDM rubber cap. Use caps suitable for required number and diameter of service penetrations. Flashing is for Division 21, 22, 23, 25 and 26 use only. Coordinate with Division 26 to minimize the number of flashings required.

3 Execution

3.1 **GENERAL**

3.1.1 Instruct and supervise other Sections doing related work.

3.1.2 Supply the measurements of equipment to other Sections to allow for necessary openings to be left in the work of other Sections.

3.1.3 Install pipes, ducts, and tubing, which are to be concealed, neatly and close to building structure so that the necessary furring can be kept as small as possible.

3.1.4 Install all ceiling components in direct accordance with reflected ceiling plans.

3.1.5 Mechanical Drawings show approximate locations for wall-mounted devices and fixtures. Clarify exact location and mounting height with Consultant prior to roughing-in.

3.2 **DISSIMILAR METALS**

3.2.1 Separate dissimilar metals by means of gaskets or shims of approved material or use dielectric unions or flanges in order to prevent electrolytic action. Where piping of dissimilar metals is connected, use approved dielectric unions or couplings. A brass fitting or brass valve may also be used in making connections between copper and steel piping.

3.3 **STORAGE OF MATERIALS**

3.3.1 Provide proper weatherproof storage for the protection of materials and equipment on site. Blank off openings in all equipment until required for use. Consultant may require materials which are not properly stored to be discarded and removed from the site.

3.4 **PIPING**

3.4.1 **General**

3.4.1.1 Conceal all piping except in equipment rooms, unfinished areas, and where specifically noted. Unless shown otherwise, install all above ground piping parallel to building walls and partitions.

3.4.1.2 Where piping is exposed, install escutcheon plates at walls, floors, and ceilings. Install piping to conserve headroom.

3.4.1.3 In locations where space is provided for future or other equipment requiring connection to systems installed under this Contract, install services with isolation valves and caps to allow connection to the system without interruption.

3.4.2 **Drain Hose Connections:** Provide drain hose connections at the base of all risers, on the suction side of all pumps and in all locations shown on Drawings.

3.4.3 **Supports and Hangers**

3.4.3.1 Provide all hangers, supports and sway braces in accordance with ANSI B31.1 and the Ontario Building Code. Support all piping in accordance with the Ontario Building Code.

3.4.3.2 Where specified and/or shown on Drawings and in schedules, use spring hangers. See Drawings for details.

3.4.3.3 Unless specified otherwise, support piping at maximum spacing as shown and within 450 mm (18") of each side of all valves and bends.

3.4.3.4 Support horizontal cast iron drainage piping at 1.5 m (5') maximum spacing. Where the drain has successive fittings with no straight piping run between the fittings of at least 800 mm (32") in length, support the drain at intervals not exceeding 900 mm (3'). Where mechanical joints are used, provide double hangers and sway bracing.

3.4.3.5 Where cast iron pipe with mechanical joints is used, support piping on both sides of horizontal joints within 450 mm (18") of joint on each side, at all branch ends, and at all points where there is a change in direction. Where the pipe is 150 mm (6") or larger in horizontal runs, brace to prevent horizontal movement at each branch or change in direction. Use braces, blocks, rodding, or other suitable method recommended by the joint manufacturer. For piping sizes of 150 mm (6") and larger, provide Inspection Report from the manufacturer’s representative certifying the installation is in accordance with their published installation data.

3.4.3.6 Do not support piping from other piping or equipment, or from metal roof decking.

3.4.3.7 **Schedule:**

Pipe Size mm	**20**	**25**	**32**	**40**	**50**	**65**	**75**	**100 to 200**	**250 & Over**
Max. Span m	1.8	2.1	2.4	2.4	3	3.4	3.7	4.3	6.1

Pipe Size in	**3/4**	**1**	**1-1/4**	**1-1/2**	**2**	**2-1/2**	**3**	**4 to 8 incl.**	**10 & Over**
Max. Span ft	6	7	8	8	10	11	12	14	20

3.4.4 **Anchors:** Install anchors where shown and where required. Use “U” bolts for piping 75 mm (3") in diameter and less. For piping over 75 mm (3") diameter, use steel fabricated anchors welded directly to pipe.

3.4.5 **Provision for Expansion:** Make proper allowance for thermal expansion and contraction whether shown on the Drawings or not. Use adequate offsets on all takeoffs to allow for expansion and contraction of mains. Weld all steel pipe forming an expansion loop regardless of size. Silver solder all copper pipe forming an expansion loop regardless of size. Use pipe alignment guides where shown and where required. Provide pipe guides for piping on either side of expansion loops, expansion joints and expansion compensators in accordance with “Standards of the Expansion Joint Manufacturers Association, Inc.”.

3.4.6 **Elevators:** In elevator machine rooms, do not locate any piping above any elevator equipment.

3.5 **ROOFTOP SUPPORTS**

3.5.1 Mount all new ductwork and piping on elevated rooftop supports. Provide the services of a factory trained representative to visit the site and review the installation.

3.5.2 For piping and ductwork supports, use maximum 3 m (10') spacing. Install strictly in accordance with the manufacturer’s published installation guidelines and installation details on Drawings. Obtain correct adhesive from roofing supplier.

3.6 SUPPORTS AND BASES

3.6.1 Provide structural work required for installation of equipment provided under this Division.

3.6.2 Where piping and/or equipment is to be supported by steel stud walls, use brackets and supports which attach to steel studs. Support equipment independently of wall sheathing.

3.7 CONCRETE INSERTS

3.7.1 General

3.7.1.1 Anchors for the support of pipes, ducts, and equipment from the underside of suspended structural concrete systems may be either cast-in-place type, placed prior to the pouring of concrete, or wedge type anchors, placed in holes drilled after the forms are stripped. The use of inserts cast into the concrete is the preferred option.

3.7.1.2 The safe load capacity of concrete anchors is affected by a number of variables such as specific anchor type, embedment, spacing between individual anchors, edge distances, direction of loading, concrete strength and “prying action”. Refer to the manufacturer’s recommendations for each specific insert proposed, including any dynamic or vibratory loads.

3.7.1.3 Be responsible for the proper selection and installation of inserts, including number, type, spacing, and accurate placement to provide the necessary safe load capacity and satisfactory long term performance.

3.7.2 **Installation of Cast in Place Inserts:** Ensure that anchors are accurately placed and “fixed” in position with sufficient rigidity to maintain their position during the placement of concrete. Do not displace reinforcing to install anchors without the prior permission of the Consultant.

3.7.3 Installation of Inserts in Hardened Concrete:

3.7.3.1 Use inserts placed in pre-drilled holes. Do not use powder driven inserts or self-drilling inserts. Before drilling holes, accurately locate all reinforcing bars in the affected areas using an electro-magnetic locator.

3.7.3.2 Do not drill through or otherwise damage reinforcing bars. If reinforcing is encountered, the inserts must be relocated. Ensure that hole diameter, depth of penetration, spacing, etc., are in strict accordance with the insert manufacturer’s recommendations for the specific insert type and load condition.

3.7.3.3 Due to the relatively close spacing of reinforcing bars in the bottom of many of the beams and girders, the preferred location of drilled-in-place anchors in beams and girders is into the sides of these members, rather than upwards into the bottom.

3.7.3.4 Inserts to be zinc plated female concrete anchors. Nylon or plastic anchors are not acceptable.

3.7.4 Concrete screws without anchors are not acceptable.

3.8 SLEEVES

3.8.1 Except as approved otherwise by the Consultant, install sleeves embedded in concrete in accordance with the following general guidelines:

3.8.1.1 Centre to centre spacing to be not less than 3 diameters of the maximum size adjacent sleeve.

3.8.1.2 Provide additional reinforcing at points of congestion as directed by the Consultant.

3.8.1.3 Sleeves through beams will be permitted only as directed by the Consultant.

3.8.1.4 The reinforcing in beams, slabs, and columns must not be displaced from its intended position under any circumstances unless prior written approval is obtained from the Consultant.

3.8.2 Provide sleeves for insulated pipe large enough to permit free movement of pipe without crushing the insulation.

3.8.3 Provide sheet metal framing around ducts through masonry walls in exposed areas to ensure a clean finish around ducts.

3.9 FIRESTOPPING AND CLOSURES

3.9.1 Provide a listed firestop system in accordance with the Ontario Building Code to seal around all piping, tubing, ducts, conduits, electrical wires and cables, and other similar mechanical services which penetrate part of a building assembly required to have a fire resistance rating or a fire separation. All penetrations throughout the building are to be considered 2 hour rated, unless noted or specified otherwise.

3.9.2 Where applicable, refer to Architectural Drawings and/or Specification Section “Firestopping and Smoke Seals”, for building assembly and fire separation types and locations.

3.9.3 For all penetrations through fire separations required to have a fire resistance rating, use firestop systems with an F rating not less than the fire resistance rating for the fire separation. This includes the sealing of any sleeves provided for future uses.

3.9.4 Provide an FT rated firestop where required by the Ontario Building Code.

3.9.5 For all penetrations through a Service Room floor, provide a minimum W rating - Class 1 in addition to the fire resistance rating.

3.9.6 At each fire stopping penetrating location, provide a fire stopping identification label indicating the system number installed, products used, date installed and installer's name. Locate label on penetrating service at the penetration location, on both sides.

3.9.7 All firestopping must be reviewed by the Consultant on site before any firestopping is concealed. Complete three destructive tests to confirm compliance with ULC listing, minimum one floor test and one wall test, third test to be Contractor's choice. Contractor to replace fire stopping system after destructive test has been completed. Submit a copy of the testing report to the Consultant. Report to include as a minimum: confirmation fire stopping Shop Drawings were used during review, locations where destructive testing was completed, confirmation that all fire stopping locations were reviewed, and that installed systems meet the manufacturer requirements.

3.9.8 Install duct fire damper assemblies in strict accordance with manufacturer's instructions provided with each assembly.

3.10 ACCESS DOORS

3.10.1 Supply access doors wherever equipment, valves, dampers, life safety devices, etc., are concealed behind walls or inaccessible ceilings. All devices installed requiring periodic maintenance to be made accessible. Doors will be installed by General Trades.

3.11 ELECTRICAL WORK

3.11.1 Perform all electrical work included in the work of this Division in accordance with the requirements of Division 26.

3.12 IDENTIFICATION

3.12.1 Piping and Ductwork

3.12.1.1 Identify all new piping and ductwork using name labels. Apply labels at 7 m (24') intervals and at all branch connections and access panel locations. Mark each pipe in a space or area less than 7 m (24') at least once with a name

label. Apply flow directional arrows beside each name label. Identify fan system number at each ductwork label. Apply piping labels in accordance with Detail Sheet at the end of this Section.

3.12.1.2 To ensure permanent bond, apply 3M Adhesive EC-1341, or equivalent, to the surface of the insulation or pipe material. Apply the label with its own adhesive on this surface. Remove any labels that are “lifting” or “peeling”. Clean the surface and repeat the procedure specified with a new label. Where labels do not adhere, use pipe banding tape spirally wrapped for full length of label. Apply label over the banding tape.

3.12.1.3 Provide colour bands on all piping. Use colours in accordance with Brock University standard for identification of piping systems. Submit list with all proposed colours and materials to the Consultant for review before ordering any materials.

3.12.2 **Valves and Dampers**

3.12.2.1 Identify all manual and automatic control valves on all systems using brass tags attached with non-ferrous chains. For existing buildings, obtain copies of the existing valve tag schedules and follow the existing numbering system format using higher numbering sequential to existing numbers. Prepare a schedule of all tags for each system showing designating number, service, and function. Include these schedules in the Operating and Maintenance Manuals and in the Mechanical Room.

3.12.2.2 Provide identification of all duct balancing dampers. Identify both support points of balancing damper and bottom of duct. Fluorescent orange spray paint is acceptable.

3.12.3 **Equipment**

3.12.3.1 Where equipment is concealed above accessible ceilings, indicate location using coloured-coded marking devices, approved by Consultant, fastened to the ceiling components.

3.12.3.2 Provide nameplate identifying equipment type, identification number, service, and area served on each piece of mechanical equipment. For heat pumps, exhaust fans, condensing units, roof top air handling units, etc. list the rooms served by each piece of equipment.

3.12.3.3 Contractor is to complete owner’s asset tag information form for all new and/or relocated equipment.

3.13 CUTTING AND PATCHING

3.13.1 Where pipes and ducts are shown on the Mechanical Drawings passing through existing walls, floor slabs, and roof, cut and patch the necessary openings.

3.13.2 Before drilling holes through floors or roof slabs, accurately locate and note sizes for each required hole. Obtain approval from Consultant before any cutting is started. Electrical conduits with live wiring may be embedded in concrete floor slabs. Scan testing is required.

3.13.3 Flash holes through walls and roof to make weatherproof.

3.13.4 For penetrations through walls not required to have a fire rating, seal all spaces between pipe or pipe and surrounding wall construction with a fire-rated foam sealant. Do this as the work progresses, to avoid leaving inaccessible holes at completion of the job. For penetrations through parts of the building assembly required to have a fire resistance rating or acting as a fire separation, see Clause “Firestopping” in this Section.

3.13.5 Where equipment, ductwork, piping, or other service is removed, repair and patch wall, roof, ceiling, and floor openings to match existing materials and finishes.

3.13.6 Include the cost of all cutting and patching in the Lump Sum Contract Price for the work of Division 21, 22, 23 and 25. All cutting and patching to be done by the trade specializing in the materials to be cut.

3.13.7 Remove, modify, cut, patch, and replace ceilings where necessary to complete the work of this Division, unless this work is specifically included in another Division.

3.14 PAINTING

3.14.1 Refer to General Trades Specifications for materials and methods for painting of piping, ductwork, walls, floors, and ceilings. Primer and paint applied inside the building must comply with the VOC content limitations of Division 01 Section “Material and Product Requirements”.

3.14.2 Touch up minor damage to finish on equipment supplied with factory applied baked enamel finish. Completely refinish items suffering damage which, in the opinion of the Consultant, is too extensive to be remedied by touchup.

3.14.3 Paint all steel framework provided by this Division with a chromium oxide primer. Exposed non-galvanized hangers, racks, struts, and fasteners to be thoroughly degreased and primed, ready for painting. All steel framework outside the building is to be hot dipped galvanized.

3.14.4 Where walls are cut and patched for mechanical work, paint walls to match existing. For walls less than 9.3 m^2 (100 sq. ft), paint entire wall. For walls larger than 9.3 m^2 (100 sq. ft), paint area of patch. Painting to be completed by painting contractor.

3.14.5 Include the cost of all painting in the Lump Sum Contract Price for the work of Division 21, 22, 23 and 25.

3.15 WELDING

3.15.1 All pipe and pressure vessel welding and brazing (including for non-registered pipe systems) must be performed in accordance with TSSA approved Welding/Brazing Procedure Specifications. All individuals performing welding or brazing must hold a valid TSSA Welding or Brazing Certificate, that is appropriate and approved for the welding and brazing procedures performed.

3.15.2 All other welding performed on the project is to be compliant with CSA W59-03 (for steel) or CSA W59.2-M (for aluminum). Welding and cutting tasks shall also be carried out in accordance with CSA 117.2. Welding is to be performed by tradesmen certified to CSA W47.1 (steel), or CSA W47.2 (aluminum) as appropriate. Welding inspectors shall be qualified to CSA W178.2. Provide proof of certification to Consultant upon request.

3.15.3 All welding of stainless steel to be performed in accordance with the requirements of the American Welding Society Standard AWS D1.6/1.6M. When provisions of this standard conflict with the provisions of the applicable CSA standards, the CSA standard requirements shall take precedence.

3.16 USE OF FANS

3.16.1 Do not use any fan supplied under this Contract for ventilation while the building is under construction. The building must be “broom clean” and all painting finished before permission will be granted for testing fans.

3.16.2 The Consultant reserves the right to use any piece of equipment, device, or material for such reasonable lengths of time and at such times as may be required to make a complete and thorough test of the same before final completion and acceptance of the work. Such tests are not to be construed as evidence of acceptance of the work, and it is agreed and understood that no claim for damage will be made for injury or breakage to any part or parts of the equipment and/or materials due to the aforementioned tests, where such injuries or breakage are caused by a weakness or inaccuracy of parts, or by defective materials and/or workmanship of any kind. Supply all labour and equipment required for such tests. Trial usage will not initiate or affect in any way the warranties required for devices being tested.

3.17 PIPING SYSTEMS INSPECTION AND TESTING

3.17.1 General

3.17.1.1 Inspect and test all piping systems. Do not cover, conceal, or close in piping until inspection and tests are completed. Thoroughly test all systems before making arrangements for the final demonstration in the presence of the Owner's staff.

3.17.1.2 Coordinate and schedule all tests with the Consultant and/or Owner. Document all tests immediately after the work is completed. Note all deficiencies and malfunctions. Promptly rectify and complete testing before issuing reports. Provide completed approved test reports, signed by the technical representative doing the work.

3.17.1.3 At the completion of the work, demonstrate operation of all systems to the Owner's representative and the Consultant. Promptly rectify any malfunction found and retest.

3.17.2 **Soil, Waste, Vent and Building Drains:** Seal all openings in section under test, then fill with water to a height of 3 m (10') above top of section. Maintain water level for at least two hours. Test in sections as the work progresses. After all fixtures have been placed, apply a smoke test to the satisfaction of the local Plumbing Inspector.

3.17.3 **Fire Protection Systems:** Test in accordance with current NFPA and Fire Underwriter's Survey (FUS) recommendations. Where Factory Mutual is referenced in Fire Protection System Specifications, test in accordance with Factory Mutual Requirements.

3.17.4 Water Systems

3.17.4.1 Unless specified otherwise, apply a hydrostatic test of 1050 kPa (150 psig) or 1-1/2 times working pressure, whichever is greater, for two hours. High pressure steam piping to be tested at 2750 kPa (400 psig), unless specified otherwise.

3.18 PERFORMANCE VERIFICATION

3.18.1 All major equipment and systems must be thoroughly tested by the Technical Representative of the equipment or system manufacturer. This testing will occur before arrangements are made for the final demonstration in the presence of the Owner's staff.

3.18.2 At the completion of the work, demonstrate operation of all systems to the Owner's representative and the Consultant. Promptly rectify any malfunction found.

3.18.3 Systems to be tested include air handling units, all major heating and cooling equipment, any specialty plant equipment such as air compressors or medical gas equipment, terminal units such as fan coils or heat pumps, and control system. The manufacturer's representative must be present for the test period and submit a Certificate of Operation to the Consultant.

3.19 START-UP SERVICES

3.19.1 Provide the services of a qualified person to be on call and available to the site within one hour, for four weeks after work of this Contract is taken over by the Owner. Assist Owner's staff to become familiar with the system operation. Provide a similar service for one week after switchover to the opposite air conditioning cycle (heating or cooling).

3.20 PLACING IN OPERATION

3.20.1 Upon completion of all work and before turning over the job, test each system for proper operation.

3.20.2 Flush through all drains and properly adjust flush valves and other fixtures.

3.20.3 Open and clean all new and existing traps, strainers, and scale pockets after two weeks' operation.

3.20.4 Clean out all new and existing room heating units, terminal heating and cooling units, volume boxes and all air handling equipment with a vacuum cleaner when building is completed.

3.20.5 Steam clean all existing convectors and wall-fin elements in the rooms where changes have been made. Do this after all other work has been completed.

3.20.6 Engage chemical treatment vendor of Owner's choice (Suez Water Technologies) to oversee cleaning and treatment of hydronic system. Completely flush system and refill with chemical cleaning compound. Operate the system for 24 hours at as high a temperature as possible with all control valves wide open, so that the compound reaches all parts of system. Drain, thoroughly flush and refill. Add corrosion treatment chemicals in recommended quantity to final filling. Provide report from chemical treatment vendor at completion of work.

3.21 SPARE PART TURNOVER TO OWNER

3.21.1 For each new filter bank, provide one extra set of filters.

3.21.2 Refer to equipment Specifications for provision of spare parts, terminal units, etc.

3.22 COOPERATION BETWEEN TRADES

3.22.1 Cooperate and coordinate with other trades as required for satisfactory and expeditious completion of work. Take field dimensions relative to work. Fabricate and erect work to suit field dimensions and field conditions. Pay cost of extra work caused by and make up time lost as result of failure to provide necessary cooperation information or items to be fixed to or built-in, in adequate time. Cost of labour and materials for rework, and costs arising from time delay, required due to lack of cooperation or coordination between trades, will not be compensated by owner.

3.22.2 Ensure required minimum service clearances for equipment and devices installed by other Trades, such as Electrical, are respected and accommodated. Do not install equipment or services within these required clearances, or blocking access to electrical junction boxes or pull boxes, access doors, etc. Notify consultant if clearance requirements cannot be met.

3.23 MAINTENANCE OF EXISTING SERVICES

3.23.1 Take every precaution to locate and protect existing services so that no unscheduled interruption occurs. If any existing service is damaged due to the work of this Division, arrange and pay for repair. Bear any costs due to interruption of existing services.

3.23.2 The operation of the building by the Owner for day-to-day activities takes precedence over all construction related activities, particularly those activities that require system or service shutdown, or that generate noise, dust, or odour. The Contractor may be asked to cease work immediately in these instances and directed to work at another time. Assume all construction related activities which will impact the day-to-day operations of the facilities will be performed after regular building occupied hours, either at night or on weekends. Include all costs associated with after hours and overtime hours in the Base Bid. Additional cost claims related to after hours or overtime hours after contract award, will not be entertained.

3.23.3 Permission from the Owner is required before making any connections to or rerouting of existing services. Before any interruptions of service or restriction of use of any service, provide seven days prior written notice to the Consultant and Owner.

3.24 PROTECTING AND MAKING GOOD

3.24.1 Be responsible for protection of Owner’s property, as well as finished and unfinished work, from damage due to execution of work under this Contract. Repair damage resulting from failure to provide such protection to the satisfaction of the Consultant, at no expense to the Owner.

3.24.2 Attach and fasten fixture and fittings in place in safe, sturdy, secure manner so that they cannot work loose or fall or shift out of position during occupancy of building, as the result of vibrating or other causes in normal use of building.

3.25 REMOVAL OF EXISTING MATERIAL AND EQUIPMENT

3.25.1 Remove existing material and equipment where shown or specified. Unless noted or specified otherwise, all material and equipment which is removed becomes the property of the Contractor and must be immediately removed from the site.

3.26 CONNECTING TO EXISTING SERVICES

3.26.1 Prior to starting the work, and prior to any related demolition work, field review and locate all points of connection to existing services. Investigate and determine existing services sizes, service locations and flow directions, and confirm compatibility with the work shown on the Drawings. Alert the Consultant to any conflicts or inconsistencies prior to proceeding with any work. Contracting team is responsible for connecting all new services to the correct existing piping and ductwork, in order to achieve correct flow direction and system operation.

3.26.2 For existing sewers, contractor to use a camera or complete a scan to confirm exact location of sewers prior to excavation. Prior to connecting to an existing sewer, the contractor is to perform dye test or camera investigation to confirm whether the sewer serves a sanitary or storm system. Connect to the appropriate sewer.

3.27 EXAMINATION OF EXISTING EQUIPMENT

3.27.1 Report all damaged, defective, and non-functioning equipment shown for reinstallation or relocation to the Consultant prior to removal and storage. All equipment will be assumed to be fully functional unless reported otherwise prior to removal.

3.27.2 Devices and equipment damaged during removal, storage, or reinstallation will be replaced at no cost to the Owner.

3.28 PHASING

3.28.1 The work on this project is to be phased to enable continuous operation of the Owner’s facilities. See the Architectural Drawings and Specifications regarding the proposed phasing of the work. Provide for temporary services, connections, bypasses, etc. to enable the phasing as described. Carry all associated costs in the Bid.

3.29 FIRE SAFETY IN EXISTING BUILDINGS

3.29.1 Where temporary shutdown of sprinkler systems, standpipe systems, or other fire protection systems is required, do all work in compliance with Clause 1.1.1.1, Clause 2.8.2.1.5, and Subsections 6.4.1 and 6.5.2 of the Fire Code.

3.30 INTEGRATED SYSTEMS TESTING OF FIRE PROTECTION SYSTEMS

3.30.1 Coordinate and work with Electrical Trade and third party Integrated Testing Coordinator, to provide Integrated Systems Testing of Fire Protection and Life Safety Systems in accordance with CAN/ULC S1001, as required by the Ontario Building Code. Refer to Specification Section 28 31 00 Appendix "Integrated Systems Testing of Fire Protection Systems". Promptly address and correct any related deficiencies or issues.

3.30.2 For phased projects, test report submission will be required at completion of each phase prior to turnover to Owner.

3.30.3 Systems to be tested include, but are not limited to:

- Sprinkler Systems
- Smoke and Fire Dampers

3.31 DEFICIENCY REVIEW

3.31.1 The Mechanical Contractor shall confirm in writing that the work is complete and ready for inspection. The Consultant will schedule a site visit to review the work and provide a written deficiency list. Once deficiencies have been corrected, the Mechanical Contractor shall confirm in writing to the Consultant that all deficiencies have been corrected. The Consultant will schedule a second site visit to review the correction of noted deficiencies. Should any noted deficiencies be found to be still outstanding, the Mechanical Contractor shall correct them and again notify the Consultant in writing. Charges to the Mechanical Contractor may result from repeat visits after the second visit.

3.31.2 The Mechanical Contractor is required to complete all work above ceilings and allow time for deficiency reviews and correction of noted deficiencies in a timely manner in order to accommodate the current Construction Schedule. This includes time for reinspection as required prior to concealing (drywall enclosures, drywall ceilings and acoustic tile ceilings) of any service. The Mechanical Contractor will be responsible for uncovering any concealed services for inspection.

3.32 HOURLY LABOUR RATE

3.32.1 Hourly labour rate shall be the actual rate paid to the worker as posted by the local Union Agreement plus a burden mark-up of 100% to compensate for contributions, assessments, employment insurance, health insurance, pension plans, WSIB, taxes, vacation pay, travel, parking, welfare, union package and membership dues, supervision, material handling, training, rest periods, down time, breaks, personal hygiene, small tools, clean up time, profit, other benefits paid to the worker and all other costs incurred by the Company including meetings, office time, project warranty updates and office project management time. Travel time to and from the site shall be at no charge to the Owner. For the purpose of mechanical work, the journeyman plumber union rate will be used for all trades completing any mechanical work.

3.33 TEMPORARY WATER SERVICE

3.33.1 Provide a Reduced Pressure type backflow preventer at each temporary water service connection used for construction purposes. Completely remove all temporary facilities once permanent systems are tested and operational.

3.34 ALTERNATIVE, SEPARATE, UNIT AND IDENTIFIED PRICES

3.34.1 Refer to Division 01 Specifications.

3.35 CASH ALLOWANCES

3.35.1 Refer to Division 01 Specifications.

3.36 LIST OF MECHANICAL SUBCONTRACTORS AND MANUFACTURERS

3.36.1 In the Bid documents, name the Subcontractors and Manufacturers for the items listed below. Use only one name for each item. See Clause “Material and Equipment”. Where the name of a manufacturer is not entered on the Bid Form, the Contractor will be required to use the base specified manufacturer.

3.36.2 Subcontractors

Building Automation System
Insulation
Sheet Metal
Sprinkler System
Testing and Balancing

3.36.3 **Manufacturers**

Air Terminal Units
Fan Coil Units
Grilles, Registers and Diffusers
Heating Units

END OF SECTION

1 General

1.1 **GENERAL REQUIREMENTS**

1.1.1 Conform to the requirements of Section 21 05 01, “Common Work Results for Mechanical”.

1.2 **DESCRIPTION OF SYSTEMS**

1.2.1 **Sprinkler System**

1.2.1.1 Modify and extend the existing wet type automatic sprinkler system to completely protect renovated areas, as shown on the Drawings. Design and build the system in accordance with the requirements of NFPA 13, the Ontario Building Code and Fire Underwriter’s Survey (FUS). Follow FUS guidelines for occupancy hazard classification.

1.2.1.2 In renovated areas, provide completely new sprinkler system including new main and branch piping and new sprinkler heads, to ensure existing piping doesn’t conflict with new services and to provide a new, decorative installation.

1.2.1.3 Much of the piping will be exposed to view above non-continuous ceilings. Provide sprinkler heads both above and below non-continuous ceilings. Refer to Architect’s reflected ceiling plans for locations.

1.3 **SHOP DRAWINGS**

1.3.1 Submit Shop Drawings in accordance with the Clause “Shop Drawings” in Section 21 05 01 for the following equipment and materials:

- Sprinkler Heads

1.3.2 See requirements for Design Drawings in Part 3 of this Section.

2 Products

2.1 **MATERIALS**

2.1.1 Use materials specified herein or approved equal as defined in Section 21 05 01, “Common Work Results for Mechanical” Clause “Materials and Equipment”.

2.1.2 Use only material and equipment which is Underwriters' Laboratories of Canada Listed and FUS approved for the application.

2.2 PIPE AND FITTINGS

2.2.1 Unless specified otherwise, use standard black steel pipe with screwed or flanged cast iron sprinkler fittings suitable for 1210 kPa (175 psig) pressure, cold water, non-shock. Use screwed or flanged type joints between pipe and fittings or valves. Mechanical type Victaulic or Gruvlok couplings, Canadian Underwriter's Listed and FUS approved, may be used. Ensure wall thickness of pipe is in accordance with NFPA 13 and 14 for the type of connections used.

2.2.2 If required due to system pressures, use black steel pipe with welded, screwed, or flanged sprinkler fittings suitable for 2070 kPa (300 psig) pressure cold water, non-shock.

2.3 SPRINKLER HEADS

2.3.1 Use ULC listed Tyco quick response sprinkler heads as follows:

- Model RFII concealed sprinkler with white finish in all areas with suspended ceilings, unless shown or noted otherwise
- Model RFII concealed sprinkler with finish chosen by Architect in all areas with wood or other specialty decorative suspended ceilings, unless shown or noted otherwise
- Upright sprinkler, chrome finish in all areas without suspended ceilings, unless shown or noted otherwise
- Pendent or upright sprinkler, rough bronze finish, guard, in mechanical and electrical rooms without suspended ceilings only (corrosion resistant where noted)
- Model CWS concealed type window sprinkler, white finish, where window sprinklers are shown or noted on the Drawings

2.3.2 Provide Tyco Sprinkler Cabinets with spare sprinklers and accessories. Use minimum 20 gauge steel cabinets finished in red lacquer and suitably labelled. Cabinets to contain:

- Spare sprinklers of each type, quantity per NFPA 13
- Sprinkler wrenches to suit head types

2.3.3 The following manufacturers of the above equipment will be considered equal, subject to the requirements of Clause “Material and Equipment”:

Reliable Automatic Sprinkler Co.
Victaulic
Viking Corp.

3 Execution

3.1 **INSTALLATION**

3.1.1 **Sprinkler Systems:** Provide complete systems designed, constructed, installed, and tested in accordance with NFPA 13, FUS and the Ontario Building Code.

3.2 **COOPERATION**

3.2.1 Cooperate with other trades on the job and so arrange work that no delay is caused to any other trade. Examine all Drawings paying particular attention to lighting fixtures, structural steel, heating and plumbing piping, ductwork, and electrical conduit, so that the installation of the sprinkler system will not interfere with other work.

3.3 **DRAWINGS**

3.3.1 The Fire Protection Drawings show sprinkler types and locations, main piping layouts and zoning. Use this information as a basis to produce a set of Fabrication Drawings for a sprinkler system which will completely protect all of the building areas. Coordinate the preparation of these Drawings with all other trades to avoid conflict with other services.

3.3.2 Sprinkler systems are to be designed by a Fire Protection Engineer using hydraulic calculations. Engage an Engineer registered with Professional Engineers Ontario who specializes in Fire Protection Engineering and is both qualified and insured in accordance with the requirements of Division C of the 2024 OBC. That individual will be designated herein as the Fire Protection Engineer for the project. Submit Fire Protection Engineer’s proof of liability insurance with Shop Drawings.

3.3.3 The Fire Protection Engineer will apply his or her seal to all Fire Protection Drawings prepared for construction. The Fire Protection Engineer will be responsible for General Review during Construction for the work of this Section, in accordance with the 2024 OBC.

3.3.4 The Fire Protection Engineer is to size all piping and indicate sprinkler head and pipe locations on working Drawings. Sprinkler head locations and quantities shown in the Bid Documents are for general layout purposes only, to identify approximate locations and quantities and sprinkler head types to be used. The Contractor is responsible for determining exact locations and quantities of sprinkler heads. Piping locations are shown where critical only. The Contractor is responsible for determining exact locations for piping.

3.3.5 Piping is to be sized to suit available pressure from the municipal water system without use of a fire pump. Use low pressure requirement sprinkler heads where required.

3.3.6 Provide sufficient number of sprinkler heads, whether shown on the drawings or not, to achieve coverage as required by NFPA 13 and FUS.

3.3.7 Prepare the Drawings in AutoCAD, matching software format of design files provided. Show sprinkler heads on Architectural Reflected Ceiling Plans. Architect will provide AutoCAD drawing files for overlays.

3.3.8 Before starting installation, submit six copies of Fabrication Drawings and Hydraulic Calculations to Fire Underwriter's Survey (FUS) for approval (email planreview@fireunderwriters.ca). Pay all costs for FUS review. Submit copies of Drawings, duly approved by FUS, to the Consultant for final review prior to commencing work. Submit two copies to local Building Department for plan review.

3.3.9 Use sprinkler heads, piping, and fittings suitable for the temperature of the environment (e.g. extremes of hot or cold, humidity). Use high temperature heads in Mechanical and Electrical Rooms.

3.3.10 Where architectural reflected ceiling plans show ceilings which are not continuous from wall to wall, provide sprinkler coverage both above and below ceiling.

3.4 SPACING OF SPRINKLERS

3.4.1 Sprinkler heads must be centred both ways within each 610 mm x 610 mm (24" x 24") portion of ceiling tile.

3.5 DRAINS, AIR VENTS AND TEST CONNECTIONS

3.5.1 Provide drain cocks with hose thread at all low points of the system not drainable through the main drain valve at service entrance, in accordance with NFPA 13 requirements. Provide air vents, flushing and test connections as required by NFPA 13 and FUS.

3.6 EXPOSED AREAS

3.6.1 In all areas exposed to view, provide a decorative grade installation. Pay particular attention to neat pipe layout. Degrease all pipe and fittings, to be suitable for painting.

3.7 SYSTEM FLUSHING

3.7.1 Flush the complete sprinkler system after installation.

3.8 TESTING

3.8.1 Test complete system in accordance with Underwriters' Laboratories of Canada, NFPA 13 and FUS requirements. Notify Consultant a minimum of 48 hours in advance of each test so arrangements can be made to have these tests witnessed. Note that work may progress in a phased manner and the systems will need to be tested and made operational in phases.

END OF SECTION

1 General

1.1 **GENERAL REQUIREMENTS**

1.1.1 Conform to the requirements of Section 21 05 01, “Common Work Results for Mechanical”.

1.1.2 The work to be performed under this Section includes the performance testing and balancing of all heating, ventilating, air conditioning and liquid system equipment installed or modified under this project, including all labour, materials and equipment required to carry out this work. Cooperate and collaborate with the Mechanical Contractor, who will operate the systems and, upon request from the Testing and Balancing Contractor, will make any required adjustments to the systems required in order to achieve the specified and intended performance.

1.1.3 The principal items of work are as follows:

- Performance testing and balancing of all equipment installed or modified under this project, including existing equipment serving renovated areas
- Provision of new sheaves and belts for existing fans as required to achieve specified air quantities
- Survey the installed automatic controls and verify their functional performance
- Test performance of all vibration isolation equipment
- Commissioning in accordance with Division 01 specifications

2 Products

2.1 **GENERAL**

2.1.1 Furnish all test equipment. All equipment will remain the property of the testing and balancing company. Use recently calibrated instruments. Provide verification of calibration to the Consultant when requested.

2.1.2 Approved testing and balancing companies for this project are:

Air Audit, Cambridge
C. J. Zettler & Associates, London
Design Test and Balance, Mississauga
Verify, Toronto

2.2 **MATERIALS**

2.2.1 Use materials specified herein or approved equal as defined in Section 21 05 01, “Common Work Results for Mechanical”, Clause “Material and Equipment”.

2.3 **DUCT ACCESS HOLE PLUGS**

2.3.1 Use Duro Dyne Type IP 4 duct access hole plugs.

3 Execution

3.1 **GENERAL**

3.1.1 Include all labour, engineering, and test equipment required to test, adjust, and balance all equipment and systems installed or modified under this project.

3.2 **JOB CONDITIONS**

3.2.1 Prior to the start of work on the site, review with the Mechanical Contractor the location of balancing devices, test connections and access openings and configurations shown on the Drawings. Identify any issues which could compromise system performance. Submit to the Mechanical Contractor and the Consultant written guidelines concerning locations and configurations of equipment and devices involved in the Testing and Balancing work. The Mechanical Contractor is to obtain the approval of the Testing and Balancing Contractor before relocating any of these devices due to field conditions. During testing, ensure that all testing, balancing, and metering devices are installed properly and in the agreed locations. Report any errors, concerns, or issues to the Consultant.

3.2.2 Schedule the Testing and Balancing work in cooperation with other trades involved. Testing and Balancing Contractor is to cooperate with the Mechanical Contractor and provide adequate prior notification of all requests for services of tradesmen, and is to coordinate their efforts so that items requiring replacement or are subject to delivery delays (sheaves, motors, etc.) are tested as early as possible.

3.2.3 Do not begin testing and balancing until the systems have been completely installed, tested, and put in running order. Correct operation of equipment and system components and cleanliness of piping and ductwork is the responsibility of the appropriate trade.

3.3 **CO-OPERATION WITH OTHER TRADES**

3.3.1 The mechanical and electrical and other related trades are to cooperate with the Testing and Balancing Contractor and provide the following assistance and services:

- Schedule sufficient time so that the testing and balancing work can be completed in a timely manner, well in advance of Owner’s use or occupancy

- Inform the Testing and Balancing Contractor of any significant changes made during construction. Provide them with a set of up-to-date Drawings, and approved Shop Drawings
- Provide and install balancing devices, test connections, access openings, balancing probe inlets and plugs as required for Testing and Balancing
- Clean, start and pre-run all equipment, filters, etc. and place all HVAC systems into full operation, and continue same, during each working day of testing and balancing
- Provide immediate labour from pertinent trades, and tools, equipment, and materials to make equipment and system alterations and adjustments, as required, including control adjustments
- Make available all equipment data (shop drawing performance data and operating instructions) to the Testing and Balancing Contractor

3.3.2 As part of the coordination process, the Mechanical Contractor is to be fully responsible for construction and adjustment of the equipment and systems to achieve optimum performance. Any readjustments or re-testing required, as the result of spot checks by the Owner or Consultant, are to be performed promptly, at no additional cost to the Owner.

3.4 SUBMITTALS

3.4.1 Submit site visit reports, review and recommendation reports as the work progresses. Refer to Division 01 specifications and/or Drawings for work sequence and phasing. Provide a Testing and Balancing Report for each phase of work, at its completion.

3.4.2 Record all test data and submit reports in PDF format to the Consultant. A copy of the reviewed final report is to be included in the Operation and Maintenance Manual.

3.4.3 Use data sheets which are approved by the Consultant to record measurements. Include schematic diagrams of all systems identifying branches, inlets, outlets, and equipment. Submit sample sheets for review using same procedure as for Shop Drawings.

3.4.4 Provide a Deficiency List to the Contractor for all materials and installation methods which are found not to be complying with the Specifications and, where specified, quantities could not be achieved within the required tolerances. Submit copy of Deficiency List to the Consultant at the same time it is issued to the Contractor.

3.4.5 Reports are to be prepared and presented in either SI or IP units, as required to match the units presented on the Drawings. Reports that include both SI and IP units will also be accepted.

3.5 PROCEDURES

3.5.1 Review all pertinent plans, specifications, shop drawings, interference drawings and other documentation to become fully familiar with the systems and their specified and intended performance.

3.5.2 Check rotation of all fans and pumps. Advise appropriate trade if any corrections are needed. Ensure corrections are made before starting any testing or balancing.

3.5.3 Ensure that all control valves, devices, and equipment interlocks are operating in the manner required for the correct performance of the systems.

3.5.4 Report any objectionable noise or vibration and be prepared to locate cause by instrumentation and analysis.

3.5.5 Operate, test, and balance all systems over their entire design range of operation. Fully simulate both heating and cooling conditions. Record sufficient data to verify compliance with design requirements. Include minimum and maximum outside air, return air and supply air conditions.

3.5.6 Generally, balance pipework systems after the air systems are balanced. Balance systems to within the following tolerances:

3.5.6.1 For air flow rates lower than 70 L/s (150 cfm), adjust to ±10% of flow.

3.5.6.2 For air flow rates higher than 70 L/s (150 cfm), adjust to ±5% of flow.

3.5.6.3 For water flow rates, adjust to ±5% of flow.

3.5.7 Carry out testing and balancing under both extreme summer and extreme winter conditions. If you wish to simulate these conditions, obtain approval from the Consultant before beginning work.

3.6 AIR SYSTEMS

3.6.1 Test and adjust fan speeds and dampers to deliver the required air quantities. For belt driven fans, determine size of sheaves required to properly balance systems and operate systems at minimum static pressures. Install selected sheaves. For new fans, sheaves and belts will be supplied by fan supplier. For existing fans, sheaves and belts are to be supplied and installed by the Testing and Balancing contractor.

3.6.2 For each indoor and rooftop air handling unit installed or modified in the project, and for each indoor and rooftop air handling unit which serves new or renovated areas, provide a static pressure profile, including pressure drop across each individual unit component (i.e. coils, filter banks, fans, energy recovery wheels, etc) as well as static pressure in intake plenums, discharge

supply ducts and return air ducts. Include return fan pressure differential whether return fan is located within air handling unit or not.

3.6.3 For belt driven fans, variable frequency drives are not to be used for air balancing purposes.

3.6.4 Test and adjust each diffuser, grille, register, air terminal unit, fan coil unit, heat pump, etc to specified flow rate tolerances, and also adjust so as to minimize drafts in all areas.

3.6.5 **Variable Volume Systems:** Make pitot tube traverse of main supply and return air ducts to measure total air quantities. Do this for both maximum and minimum air flow rate conditions. Assist controls trade in setting static pressure setpoint at minimum required pressure. For each volume box or air terminal unit, measure minimum and maximum air flows, and inlet static pressure at each air flow measurement. Set minimum and maximum air flows as shown on the Drawings. Determine outside air damper minimum positions and return air fan speed offset from supply fan speed to suit slight positive pressurization of the renovated area. Coordinate settings with controls trade.

3.6.6 Seal duct access holes with plugs. Do not use duct tape to seal access holes.

3.6.7 Record data as specified in Clause “Balancing Data”.

3.7 BALANCING DATA

3.7.1 Include the following information in the test report:

3.7.1.1 **Motors:**

Manufacturer
Model and/or Serial Number
Rated and measured voltage
Rated and measured amperage
Corrected full load amperage
Rated and measured rpm
Rated and calculated power
Sheave size, type, and manufacturer

3.7.1.2 **Fans:**

Manufacturer
Model and/or Serial number
Rated and measured airflow rate
Rated and measured rpm
Rated and measured pressure rise
Pulley size, type, and manufacturer
Belt size and quantity

Performance curve by manufacturer
Flow Measuring Station Calibration Results (VAV Systems)

3.7.1.3 **Air Systems (including inlets and outlets):**

Volume Boxes (minimum flow and maximum flow)
Grille, register or diffuser reference number and manufacturer
Grille, register or diffuser location
Design air quantity
Effective area factor and size
Measured air quantity
Static Pressure Setpoint (VAV Systems)

3.7.1.4 **Testing and Balancing Instruments:**

Types
Serial Numbers
Dates of calibration

3.8 **FINAL INSPECTION AND ACCEPTANCE**

3.8.1 After submission of balancing report, arrange a final inspection with the Consultant.

3.8.2 At final inspection recheck points or areas selected by the Consultant.

3.8.3 For each system, if more than 10% of the measurements at the selected recheck stations deviate by 10% or more from those in the Report, then the Report for that system will be rejected as unacceptable.

3.8.4 If Report is rejected, rebalance systems deemed to be unacceptable, submit new Reports, and make reinspection at no extra cost to the Owner.

3.8.5 Permanently mark settings of dampers and other adjustment devices so that adjustment can be restored if disturbed. Type of marking and method of application to be approved by the Consultant.

END OF SECTION

1 General

1.1 **GENERAL REQUIREMENTS**

1.1.1 Conform to the requirements of Section 21 05 01, “Common Work Results for Mechanical”.

1.1.2 All products used must have a flame spread rating less than 25 and a smoke developed classification not more than 50 when tested in accordance with CAN/ULC-S102.

1.1.3 **Environmental Requirements:** Maintain ambient temperature and conditions required by manufacturers of adhesives, mastics, and insulation cements.

1.1.4 **Quality Assurance:** Insulation materials must be manufactured at facilities certified and registered to ISO 9000 Quality Standard.

1.1.5 **Storage of Materials:** Protect materials from dirt, water, chemical and mechanical damage before, during and after installation. Provide and install waterproof sheeting to protect insulation in unfinished areas as required. Remove damaged materials from the site immediately and discard. Remove and replace at no additional cost any installed materials which are damaged.

1.1.6 **Delivery:** Deliver insulation, coverings, cements, adhesive coatings, etc., to the site in Manufacturer’s original containers with the manufacturer’s stamp or label affixed showing flame and smoke ratings of the products, name of manufacturer and brand.

1.2 **DEFINITIONS**

1.2.1 In this Specification, “exposed to view” means all surfaces of all services within Equipment Rooms, Service Corridors, plus all other areas of the building where the services are not enclosed within ceilings or shafts.

1.2.2 In this Specification, “exposed to weather” means all surfaces of all services located outdoors without an architectural enclosure. It also refers to ductwork inside horizontal and vertical architectural enclosures across the roof and down the faces of the building.

1.3 **SHOP DRAWINGS**

1.3.1 Provide shop drawings which include product description, list of materials and thickness for each service and manufacturers’ installation instructions.

1.3.2 Submit Shop Drawings in accordance with the Clause “Shop Drawings” in Section 21 05 01 for the following equipment and materials:

- Duct, Piping, and Equipment Insulation Types (note application for each product)
- Finishing Cement
- Lagging Adhesive
- Pipe and Duct Insulation Coverings
- Piping Insulation Inserts
- Vapour Barrier Mastic

2 Products

2.1 **MATERIALS**

2.1.1 Use materials specified herein or approved equal as defined in Section 21 05 01, “Common Work Results for Mechanical”, Clause “Material and Equipment”.

2.2 **PIPING INSULATION INSERTS**

2.2.1 Make rigid insulation inserts equal in thickness to the adjoining insulation. Use Johns Manville Thermo-12 Gold hydrous calcium silicate rigid pipe insulation. Inserts to extend up to pipe centreline on both sides. Use the following insert lengths:

Nominal Pipe Size		**Insert Length**	
mm	**(inches)**	**mm**	**(inches)**
40 - 65	(1-1/2 - 2-1/2)	250	(10)
75 - 150	(3 - 6)	300	(12)
200 - 250	(8 - 10)	400	(16)
300 and over	(12 and over)	550	(22)

2.3 **PIPING INSULATION INSERT SHIELDS**

2.3.1 Use minimum 18 gauge galvanized metal shields. Form shields to fit insulation and extend up to the pipe centre line. Shield length to be 100 mm (4") less than length of associated insert. Shield colour is to match pipe finish colour when exposed to view.

2.3.2 Use steel pipe covering protection saddles at roller hangers and pipe roll supports.

2.4 PIPE INSULATION

2.4.1 All Piping Systems Except Refrigeration

2.4.1.1 **Piping:** Use formaldehyde-free Knauf Earthwool 1000° glass fibre pipe insulation with factory applied ASJ+ all-service jacket. Insulation conductivity and thickness in accordance with Pipe Insulation Schedule. Jacket to consist of aluminum foil vapour barrier reinforced with glass scrim and laminated to a fire resistant kraft facing.

2.4.1.2 **Valves and Fittings:** Insulate valves and fittings with formaldehyde-free factory precut Johns Manville Zeston Hi-Lo Temp insulation inserts or Knauf Earthwool 1000° formaldehyde-free glass fibre pipe insulation 16 kg/m³ (1 lb/ft³) density glass fibre insulation.

2.4.1.3 The following manufacturers of the above equipment will be considered as equal, provided products are formaldehyde free, subject to requirements of Clause “Material and Equipment”:

CertainTeed
Johns Manville
Knauf
Manson

2.4.2 Pipe, Valve and Fitting Insulation Covering for Piping Exposed to View

2.4.2.1 Use Proto LoSmoke or Knauf or Walton Plastics equivalent, minimum 0.51 mm (20 mil) thickness PVC jacketing and fitting coverings. Use Proto solvent welding adhesive to permanently seal all PVC joints. Use white jackets.

2.4.2.2 The following manufacturers of the above equipment will be considered as equal, provided products are formaldehyde free, subject to requirements of Clause “Material and Equipment”:

Ideal Products
ITW

2.5 PIPING INSULATION THICKNESS SCHEDULE

Fluid Design Operating Temperature Range °C (°F)	Insulation Conductivity		Nominal Diameter mm (in)				
	Conductivity Range W/m°C (Btu·in/hr·ft²·°F)	Mean Rating Temperature °C (°F)	less than 25 (1)	25 (1) and 32 (1-1/4)	40 (1-1/2) to 75 (3)	100 (4) to 150 (6)	200 (8) and up
Heating Systems (Hot Water)							
61 - 93 (141 - 200)	0.036 - 0.042 (0.25 - 0.29)	52 (125)	40 (1.5)	40 (1.5)	50 (2.0)	50 (2.0)	50 (2.0)
Cooling Systems (Chilled Water and Refrigerant)							
4 - 16 (40 - 60)	0.030 - 0.039 (0.21 - 0.27)	24 (75)	25 (1.0)	25 (1.0)	25 (1.0)	25 (1.0)	25 (1.0)

2.6 AIR DUCTS

2.6.1 Ductwork External Insulation

2.6.1.1 On all round ducts, and on rectangular ducts not exposed to view with both dimensions 600 mm (24") and smaller, use Knauf Atmosphere formaldehyde-free flexible blanket fibreglass insulation with FSK aluminum foil-scrim-kraft paper facing. Product must meet the requirements of ASTM C1290. Maximum thermal conductivity 0.042 W/m°C (0.29 Btu·in/hr·ft²·°F). Use 40 mm (1-1/2") thickness.

2.6.1.2 On rectangular ducts exposed to view, and on rectangular ducts not exposed to view with one dimension 650 mm (26") or larger, use Knauf Atmosphere formaldehyde-free rigid fibreglass insulation board, 48 kg/m³ (3 lb/ft³) density, with FSK aluminum foil-scrim-kraft paper facing. Product must meet the requirements of ASTM C1136. Maximum thermal conductivity 0.033 W/m°C (0.23 Btu·in/hr·ft²·°F) at 24 °C (75 °F) mean temperature. Use 40 mm (1-1/2") thickness.

2.6.1.3 The following manufacturers of the above equipment will be considered as equal, provided the products are formaldehyde-free, subject to requirements of Clause “Material and Equipment”:

CertainTeed
Johns Manville
Knauf
Manson

2.6.2 **Ductwork Insulation Covering for Ductwork Exposed to View**

2.6.2.1 **Laminate Cladding:** Use Venture Tape Model 1577CWWME zero permeability, 0.20 mm (8 mil) thick, self-adhesive multi-ply embossed white laminate cladding, or Victoryclad equivalent.

2.7 **VAPOUR BARRIER MASTIC**

2.7.1 Use white Foster 30-33 or Childers CP-33 water based vapour barrier mastic. Permeance shall be 0.07 perms or less as tested by ASTM F 1249. Reinforcing mesh shall be Foster Mast a Fab or Childers Chil Glas #10.

2.8 **FINISHING CEMENT**

2.8.1 Use Ryder hydraulic setting finishing cement.

2.9 **LAGGING ADHESIVE**

2.9.1 Use white Childers CP-50AMV1 or Fosters 81-42/30-36 water based fire retardant lagging adhesive.

3 Execution

3.1 **GENERAL**

3.1.1 Install all insulation in strict accordance with manufacturer’s published recommendations.

3.1.2 Install all insulation continuous through walls and sleeves. Insulate all components of insulated systems unless specifically excluded. Extend all surface finishes to protect all surfaces, ends, and raw edges of insulation.

3.1.3 Do not apply insulation until piping has been tested and approved.

3.1.4 Do not insulate unions or flanges at connections to equipment. In these locations, and in all other locations where insulation ends, finish with vapour resistant mastic.

3.1.5 Patch and make good any existing insulation and covering which is damaged during the work of this Contract. Use material of the same quality as existing.

3.2 PIPING SYSTEMS

3.2.1 General Requirements

3.2.1.1 Insulate the following piping systems in their entirety:

- Hot water heating
- Chilled Water
- Condensate Drains

3.2.2 Insulation Application

3.2.2.1 **General:** Seal all joints in accordance with manufacturer's recommendations.

3.2.2.2 **Firestopping:** Where an insulated pipe passes through a fire separation, use only ULC labelled piping insulation in accordance with ULC Listed firestop system being used. See Section 21 05 01, Clause "Firestopping". Extend ULC labelled pipe insulation through fire separation and 50 mm (2") beyond fire separation on both sides. Tightly butt joints and wrap with approved joint tape.

3.2.2.3 **Hanger Points:** Provide an insulation insert and shield at each hanger point on all piping 40 mm (1-1/2") and larger on all systems. On cold lines, vapour seal butt joints on each side of insert with vapour barrier mastic.

3.2.2.4 **Pipe:** Apply insulation over clean dry pipe. Butt all joints firmly together. Seal all jackets neatly in place. Wrap butt joints with a minimum 75 mm (3") wide strip of the jacketing material. Use a vapour barrier adhesive on all "cold" lines and dual temperature systems.

3.2.2.5 **Fittings and Valves**

3.2.2.5.1 For pipe sizes 40 mm (1-1/2") and smaller, insulate with fibreglass blanket wrapped firmly under compression (minimum 2:1) to a thickness matching adjoining insulation. Insulation ends may be mitred at elbows and sealed with tape.

3.2.2.5.2 For pipe sizes 50 mm (2") and larger, insulate with factory precut insulation inserts or with fibreglass blanket wrapped firmly under compression (minimum 2:1) to a thickness matching adjoining insulation. Insulation ends may be mitred at elbows and sealed with tape.

3.2.2.5.3 **Cold Systems:** Apply vapour barrier mastic and reinforcing mesh on all cold service insulated elbows, fittings, flanges, valves, as well as on all cold service line size hangers less than 40 mm (1-1/2"). All vapour retarder jacket seams shall be vapour sealed with vapour barrier mastic in addition to jacket self-seal adhesive. Provide a continuous vapour barrier.

3.2.2.5.4 On components which require service, fabricate easily removable and reusable insulation sections e.g. suction guides for circulating pumps and pump casings. Test ports on balancing valves to be accessible outside of insulation.

3.2.3 **Pipe Insulation Finishes Exposed to View**

3.2.3.1 In all locations where the insulation will be exposed to view, including for refrigeration piping, finish with pipe insulation coverings. Follow strictly manufacturer's installation procedures for cold and hot systems.

3.3 **AIR DUCTS**

3.3.1 **General**

3.3.1.1 Seal all vapour retardant jacket seams and penetrations with UL Listed tape and adhesive. Coat all taped seams with 100 mm (4") wide coating of vapour barrier mastic to prevent moisture ingress on cold systems.

3.3.1.2 Externally insulate fire damper sleeve assemblies where duct system is internally lined.

3.3.1.3 Refer to Section 23 30 00, "Air Distribution", for ductwork internal lining materials and methods.

3.3.2 **System Specific Requirements**

3.3.2.1 **Supply Air Ductwork**

3.3.2.1.1 Externally insulate all supply air ductwork for all systems, including ductwork installed within return air plenums, to match the existing arrangement.

3.3.2.2 **Return and Exhaust Air Ductwork:** Externally insulate all return and exhaust duct sections specifically identified on the Drawings. Insulate the first 1.5 m (5') of exhaust air ductwork located adjacent to outside walls or roof.

3.3.3 **Insulation Application**

3.3.3.1 On round and oval ducts, adhere insulation to ducts with a flame resistant, quick tacking adhesive. Apply adhesive in 100 mm (4") wide strips at 200 mm (8") centres. Butt all circumferential joints and overlap all longitudinal joints a minimum 50 mm (2"). Staple all joints on 150 mm (6") centres. Tape all joints with minimum 75 mm (3") wide reinforced vapour barrier tape as recommended by insulation manufacturer.

3.3.3.2 On rectangular ducts, use adhesive and impale insulation over mechanical fasteners. Provide 100% coverage of adhesive on sheet metal, all exposed insulation edges, and all transverse joints. Provide mechanical fasteners per manufacturer's published recommendations. Insulate behind duct balancing damper operators.

3.3.4 **Insulation Finish for Ductwork Exposed to View**

3.3.4.1 In locations where the insulation will be exposed to view, finish with white aluminum cladding. Provide 25 mm x 25 mm (1" x 1") galvanized steel sheet metal angle corner bead over duct insulation along all duct corners. Follow manufacturer's installation recommendations.

3.3.4.2 White PVC jackets will be acceptable for round ductwork in lieu of aluminum cladding. Follow manufacturer's installation recommendations.

END OF SECTION

1 General

1.1 **GENERAL REQUIREMENTS**

1.1.1 Conform to the requirements of Section 21 05 01, “Common Work Results for Mechanical”.

1.2 **SHOP DRAWINGS**

1.2.1 Submit Shop Drawings in accordance with Section 210501, Clause “Shop Drawings”, for the following equipment and materials:

- Valves

2 Products

2.1 **MATERIALS**

2.1.1 Use materials specified herein or approved equal as defined in Section 210501, “Common Work Results for Mechanical” Clause “Material and Equipment”.

2.2 **PIPING AND FITTINGS**

2.2.1 **General**

2.2.1.1 Use the following materials for all piping systems provided by this Section.

2.2.1.2 Use long radius elbows and manufactured tees.

2.2.1.3 For all flanged connections use stainless steel spiral wound graphite gaskets in systems operating above 82 °C (180 °F). Use inorganic fibre gaskets with nitrile binder gaskets for all low temperature systems. Use minimum Grade 5, high tensile strength bolts, nuts, and washers. Use welding neck and RF flanges as per ANSI/ASME B16.5.

2.2.2 **Water and Glycol Piping for Sizes 50 mm (2") and Smaller:** Use either copper or steel pipe as follows:

2.2.2.1 **Copper**

Pipe - Type L hard drawn copper
Joints - Solder
Fittings - Wrought copper or cast bronze
Unions - 1030 kPa (150 psig) octagon end, bronze

2.2.2.2 **Steel**

Pipe - Black steel, Schedule 40, ASTM A-53
Joints - Threaded
Fittings - 1030 kPa (150 psig) malleable iron to ASME B16.3
Unions - 1030 kPa (150 psig) malleable iron, brass to iron ground joint seat to ASME B16.39

2.2.3 **Indirect Drainage and Condensate Drainage Piping:** Use seamless copper Type DWV pipe to ASTM B306 with cast or wrought copper fittings and soldered joints.

2.3 **VALVES**

2.3.1 **General**

2.3.1.1 Use the following valves for all piping systems provided by this Section, unless specified otherwise.

2.3.1.2 Use only industrial class valves meeting ANSI, ASTM, ASME and applicable MSS standards. Specification MSS-SP-80, MSS-SP-110, MSS-SP-70, 85, 71, MSS-SP-72, MSS-SP-67, API 602, API 598, API 609, API 600.

2.3.2 **Ball Valves**

2.3.2.1 **Water, Glycol:** Kitz 68AMLL/69AMLL, bronze body, full port (CGA approved) with stainless steel ball and stem. Use valves with extension stems when installed in insulated piping. Use locking lever handle where “lockable valve” is noted on the Drawings.

2.3.3 **Drain Hose Connections:** Use Kitz 68AC ball valves complete with No. 658 cap and chain.

2.3.4 The following manufacturers of the above two items of equipment will be considered equal, subject to requirements of Clause “Material and Equipment”:

Ball Valves

Apollo
Kitz
MAS
Nibco
Toyo

2.3.5 **Combination Balancing and Shutoff Valves**

2.3.5.1 Use Victaulic / Tour & Andersson Inc. STA-D and STA-F Style Balancing Valves with digital handwheels.

2.3.5.2 Balancing Valves will all be designed for flow measurement, flow balancing and positive shutoff. Size valves in accordance with manufacturer's published guidelines. Provide extended differential ports to enable access without removing insulation.

2.3.5.3 Valves to be calibrated globe style with differential ports providing flow measurement, balancing and positive shutoff. Do not exceed 9 kPa (3 ft W.C.) head at fully open position.

2.3.6 The following manufacturers of the above equipment will be considered equal, subject to requirements of Clause "Material and Equipment":

Oventrop

3 Execution

3.1 **PIPING**

3.1.1 **General**

3.1.1.1 Use flanges or unions on all piping connections to equipment.

3.1.1.2 Install all control valves, fittings, water temperature sensors and flow switches supplied by Section 25 00 00 "Controls".

3.1.1.3 See Section 210501 "Common Work Results for Mechanical" Clause "Piping".

3.1.1.4 Where connections to existing water systems are required, include cost of draining and refilling systems in Bid Price.

3.1.1.5 Provide drain valves with hose connections at base of all risers, at all low points in piping distribution, and at low points on all equipment connections.

3.1.1.6 For upfeed take off top of pipe. For downfeed take off bottom of pipe.

3.2 **VALVES**

3.2.1 Use line sized valves unless shown or specified otherwise. Use only ball valves on water piping.

3.3 **ACCESS DOORS**

3.3.1 Provide access doors with quick fastening latches for access to all dampers, coils, thermostats, valves and any other concealed devices which require servicing.

3.4 AIR AND WATER SYSTEM TESTING AND BALANCING

3.4.1 Cooperate with and assist the air and water testing and balancing company. See Section 23 05 93 “Testing, Adjusting and Balancing for HVAC”.

3.4.2 Be responsible for the initial alignment and tension of all fan pulleys and belts.

3.4.3 Provide any changes to fan drives, pulleys and belts as required to allow a proper air balance as recommended by the Testing and Balancing Company for equipment supplied under this Contract.

3.5 WATER TREATMENT SYSTEMS

3.5.1 Mechanical Contractor to flush, drain, clean and refill heating and chilled water system as directed by Water Treatment Contractor. See Section 21 05 01 Clause “Placing in Operation”.

END OF SECTION

1 General

1.1 **GENERAL REQUIREMENTS**

1.1.1 Conform to the requirements of Section 21 05 01, “Common Work Results for Mechanical”.

1.2 **SHOP DRAWINGS**

1.2.1 Submit Shop Drawings in accordance with Section 21 05 01, “Common Work Results for Mechanical”, Clause “Shop Drawings”, for the following equipment and materials:

- access doors
- duct sealer
- ductwork gauges, material and methods of support for each pressure type, shape (i.e. round, rectangular) and size range
- fire and smoke dampers
- flexible ductwork
- grilles, registers and diffusers

2 Products

2.1 **MATERIALS**

2.1.1 Use materials specified herein or approved equal as defined in Section 21 05 01, “Common Work Results for Mechanical”, Clause “Material and Equipment”.

2.1.2 All paints and coatings, adhesives and sealants that are applied onsite and fall within the building must have VOC content that does not exceed the limits listed in Section 01 67 11 Material and Product Requirements. Use GreenSeal or EcoLogo marked products.

2.2 **DUCTWORK**

2.2.1 **Standards**: Construct all ductwork in accordance with the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) Manual “HVAC Duct Construction Standards - Metal and Flexible”.

2.2.2 **Materials**: Unless specified otherwise, fabricate all ductwork from galvanized steel. Use SMACNA recommended thicknesses except where specified otherwise. Where aluminum construction is shown or specified, use utility grade aluminum. For aluminum construction, use equivalent to galvanized steel to aluminum thickness adjustments as listed in current SMACNA Manual “HVAC Duct Construction Standards - Metal and Flexible”.

2.2.3 **Rectangular - Low Pressure**: Use SMACNA 2" W.G. pressure class. Use SMACNA recommended sheet metal thicknesses. For all round take-offs from rectangular ducts use beveled rectangular to round take-offs, tapered in the direction of air flow. For rectangular take-offs serving only one terminal outlet use beveled rectangular take-offs. For rectangular take-offs serving multiple terminal outlets use full radius wye fittings.

2.2.4 **Rectangular - Medium Pressure**: Fabricate according to current SMACNA standards for static pressures in duct up to 1490 Pa (6" W.G.). For all rectangular branch connections use full radius wye fittings. For all round branch connections use tapered or conical takeoffs.

2.2.5 **Round - Medium Pressure**

2.2.5.1 Fabricate according to current SMACNA standards for static pressures in duct up to 1490 Pa (6" W.G.). Use Alpha, McGill, Plascad or Rozell spiral round or flat oval ducts. Use machine formed fittings. Use conical type takeoffs. Where round ductwork is shown or noted to be internally lined, use acoustic thermal duct consisting of spiral duct lined with 25 mm fibreglass insulation and 28 gauge steel perforated interior liner.

2.2.5.2 For sizes up to and including 200 mm (8") diameter, use machine formed fittings. In larger sizes, use machine formed or shop fabricated fittings. For shop fabricated fittings, make sample fittings and get approval of the Consultant before proceeding with fabrication of job fittings. The Consultant may require the Contractor to arrange and pay for testing of selected fittings by a recognized independent testing laboratory. For all round branch connections use tapered or conical type takeoffs.

2.2.5.3 Where round or flat oval ductwork is exposed to view, a decorative grade installation with a satin coat finish, degreased and suitable for field painting, is required. Arrange for special handling and shipping to avoid dents and minimize scratches.

2.2.6 **Flexible Type Round Ducts**

2.2.6.1 Flexible ductwork will not be permitted where exposed to view. It will only be permitted where concealed above a suspended ceiling.

2.2.6.2 Where not exposed to view, use Thermaflex Type M-KC or FlexMaster equivalent insulated flexible duct with a woven fibreglass fabric core with a flame resistant coating permanently bonded to a coated wire helix. Minimum positive pressure rating of 4 kPa (16" w.g.) for sizes 100 to 250 mm (4 to 10") and 2.5 kPa (10" w.g.) for sizes 300 to 410 mm (12 to 16"). Insulate duct with minimum 40 mm (1-1/2") thickness of 12 kg/m^3 (0.75 lb/ft^3) density fibreglass and bidirectional reinforced metallized film outer vapour barrier.

2.2.6.3 Flexible duct must bear ULC approval labels and conform to flame spread and smoke developed ratings as required by the Ontario Building Code.

2.3 SMOKE AND FIRE DAMPERS

2.3.1 Use only dynamic type fire damper assemblies tested in accordance with CAN4-S112-M "Standard Method of Fire Test of Fire Damper Assemblies" and listed in most recent ULC "List of Equipment and Materials" or by another recognized independent testing and certification agency acceptance to the Consultant. Label each damper to indicate compliance with these requirements. Provide fusible links with a 70°C (158°F) rating unless noted otherwise on Drawings. Links shall comply with ULC-S505 "Standard for Fusible Links for Fire Protection Service".

2.3.2 Fabricate all dampers from galvanized steel with galvanized steel sleeves, except in copper and aluminum duct systems. In these systems, use all stainless steel construction.

2.3.3 Provide damper assemblies whose fire protection ratings comply with Ontario Building Code requirements for the fire resistance ratings of the fire separations through which the protected openings pass. Provide an approval label, stating the fire rating, from a recognized independent testing laboratory acceptable to the Consultant, on each assembly.

2.3.4 For ducts with either face dimension of 300 mm (12") or less, and for all medium pressure ducts, use low resistance type dampers with 100% free area.

2.3.5 Provide with each damper, detailed installation instructions. Include illustrations and adequate information to attain proper and safe installation of the fire damper assemblies. Submit these with shop drawings. Submit reviewed shop drawings to municipality.

2.3.6 Provide duct access door with viewport for each SFD and SD.

2.3.7 Fire dampers must operate under both static and dynamic conditions, i.e. whether fan systems are operating or not. All dampers to be rated for airflow and leakage in either direction through the damper.

2.3.8 **Fire Damper (Drawing Reference FD):** Fire Damper to be Ruskin Model DFD60 fire damper with sleeve. Damper to close by heat-actuated device. Damper to be designed and tested to meet UL555 requirements for fire dampers.

2.3.9 **Smoke/Fire Damper (Drawing Reference SFD)**

2.3.9.1 Combination Smoke/Fire Dampers to be Ruskin Model FSD60-DTS-SP100 combination smoke/fire dampers, ULC Listed, complete with sleeve and 120-volt electric actuator. Provide optional position indicator switch pack with two SPDT switches (SP100), factory wired and installed on the side of the damper assembly, and damper test switch (DTS). Damper to be designed and tested to meet both UL555 requirements for fire dampers and UL555S for leakage Class I rated smoke dampers.

2.3.9.2 Smoke detector will be provided and installed by Electrical Trades. Damper to be powered open and to close upon smoke detection or by heat-actuated release device. Damper to operate stand alone.

2.3.9.3 Smoke detector must be installed downstream of smoke damper per OBC 3.1.8.9A(3)(b). Where ductwork downstream of the fire separation is not accessible, provide a separate smoke damper and fire damper at each SFD location, in accordance with the Details shown on the Drawings.

2.3.10 **Smoke Damper (Drawing Reference SD)**

2.3.10.1 Smoke Dampers to be Ruskin Model SD60-DTS-SP100 smoke dampers, ULC Listed, complete with installed 120-volt electric actuator. Provide optional position indicator switch pack with two SPDT switches (SP100) factory wired and installed on the side of the damper assembly, and damper test switch (DTS). Damper to be designed and tested to meet UL555S for leakage Class I rated smoke dampers.

2.3.10.2 Smoke detector will be provided and installed by Electrical Trades. Damper to be powered open and to close upon smoke detection. Damper to operate stand alone.

2.3.11 The products of the following manufacturers will be considered equal, subject to the requirements of Clause "Material and Equipment":

Alumavent
Arrow United Industries
EH Price
Greenheck
Nailor
National Controlled Air
Ruskin
United Enertech

2.4 BALANCING DAMPERS

2.4.1 For ducts 930 cm² (144 in²) and less in cross sectional area, use single blade dampers with locking quadrant and pin on far side. For larger ducts use, multi-blade, opposed blade dampers with external operator and locking quadrant. Provide spacers to maintain clearance between duct and damper blades.

2.5 INTERNAL DUCT LINING

2.5.1 Use Schuller/Manville “Permacote Linacoustic” fibreglass duct liner with air stream surface protected with “Permacote”, acrylic coating. Coating to be treated with anti-microbial agent so as not to support growth of fungus or bacteria as determined by ASTM G21 and G22. Liner to meet or exceed Life Safety Standards as established by NFPA 90A and 90B, have a NRC not less than 0.7, and a thermal conductivity of 0.36 W/m.K (0.0208 Btuh x ft x °F) at 23.9°C (75°F).

2.5.2 The following manufacturer of the above equipment will be considered as equal, subject to requirements of Clause “Material and Equipment”:

Knauf
Manson
Fiberglas

2.6 DUCT ACCESS DOORS

2.6.1 Use Nailor Industries Inc. 0800 Series duct access doors. Minimum size for access to fire damper, smoke damper or combination smoke and fire damper is 12” x 12”. For other locations, for duct dimension up to 300 mm (12") use 250 mm x 150 mm (10" x 6") door and for duct dimension up to 600 mm (24"), use 380 mm x 250 mm (15" x 10") door. For all larger ducts, use 660 mm x 510 mm (26" x 20") door. For round ducts, use Nailor 0895 access door.

2.6.2 For insulated ducts, use doors factory insulated with 25 mm (1") thick fibreglass insulation.

2.6.3 For access door with viewport, use Duro Dyne model DADVP hinged access door with frame and with plexiglass vision panel.

2.6.4 The following manufacturer will be considered equal, subject to the requirements of Clause “Material and Equipment”:

Acudor
AMI
Ductmate
Nailor
Ruskin

2.7 FLEXIBLE DUCT CONNECTORS

2.7.1 Use Duro Dyne “Durolon” pre-assembled flexible duct connectors with 150 mm (6”) fabric width, Hypalon coating.

2.7.2 The following manufacturer of the above equipment will be considered as equal, subject to requirements of Clause “Material and Equipment”:

Carlisle
Thorburn
VentFabrics

2.8 GRILLES, REGISTERS AND DIFFUSERS

2.8.1 Use E. H. Price Limited grilles, registers and diffusers. Provide types, accessories and finishes as noted in the Equipment Schedules. See Drawings for sizes.

2.8.2 The following manufacturers of the above equipment will be considered as equal, subject to requirements of Clause “Material and Equipment”:

Kreuger
Nailor
Titus
Tuttle & Bailey

2.9 HIGH INDUCTION TYPE DIFFUSERS

2.9.1 Use Kampmann high induction type diffusers. Provide types, accessories and finishes as noted in the Equipment Schedules. See Drawings for sizes.

2.9.2 The following manufacturers of the above equipment will be considered as equal, subject to requirements of Clause “Material and Equipment”.

Effectiv HVAC
Klimaoprema
NAD Klima
Trox

2.10 DUCT SEALER

2.10.1 Use Duro Dyne DWN water based high pressure duct sealer.

2.10.2 The following manufacturers of the above material will be considered as equal, subject to requirements of Clause “Material and Equipment”:

Childers
Multi-Purpose
3M Canada Inc.
United Sheet Metal

2.11 **TURNING VANES**

2.11.1 Use Rouane turning vanes as manufactured by S.E. Rozell and Sons Ltd. in all square elbows. Assemble vanes with Duro Vane Rail JVR-2 for 50 mm (2") radius vanes spaced 38 mm (1-1/2").

2.12 **AIR TERMINAL UNITS**

2.12.1 Refer to Section 23 80 00 “Decentralized HVAC Equipment”.

3 Execution

3.1 **DUCTWORK**

3.1.1.1 Seal all openings in HVAC systems with plastic. While duct installation is proceeding, seal all openings that are not under immediate work.

3.1.2 **General**

3.1.2.1 Construct ALL ductwork located inside Mechanical Equipment Rooms and all supply air ducts on systems with variable air volume terminal units, between the fan outlets and the terminal unit inlets, to Medium Pressure duct standards. Construct all ducts designated on Drawings as round or oval to Medium Pressure duct standards. Unless specified otherwise, construct ALL other ductwork to Low Pressure duct standards.

3.1.2.2 Fabricate and install ductwork in accordance with the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) Manual “HVAC Duct Construction Standards - Metal and Flexible”.

3.1.2.3 Pay particular attention to Section 210501 “Common Work Results for Mechanical”, Clause “Cutting and Patching”. This will be strictly enforced on this project. Coordinate work with trades responsible for floor and wall construction to reduce difficulty of making tight seals.

3.1.2.4 Where specifically identified in the Drawings, use the heavier gauge ductwork materials noted.

3.1.2.5 Fabricate all ductwork to the clear inside dimensions shown on the Drawings. Where internal lining is specified, dimensions shown are inside insulation.

3.1.2.6 Do **not** suspend ducts from metal roof deck.

3.1.2.7 Make duct connections to fans, air handling units and connections between air handling units and plenums, with flexible duct connectors.

3.1.2.8 Install access doors for easy access to each damper, thermostat, coil, valve, or other concealed device which requires servicing.

3.1.2.9 Install access doors in all other ductwork at not more than 12 m (40") intervals, and at the bases of all main risers.

3.1.2.10 Provide additional access doors as required by the duct cleaning contractor at no additional cost.

3.1.2.11 Install fire damper assemblies in strict accordance with manufacturer's instructions provided with each fire damper. See Detail Sheet in Section 21 05 01 “Common Work Results for Mechanical” for installation requirements where ducts are internally lined.

3.1.2.12 Install dampers and duct sensors as supplied by Section 25 00 00 “Controls”. Exact locations to be determined by Section 25 00 00.

3.1.2.13 Where ductwork has to be altered from dimensions shown due to construction conditions, use the same effective cross sectional areas, without exceeding a 3 to 1 aspect ratio. Carry out such changes at no additional cost to the Owner.

3.1.2.14 Install ductwork to maximize clear floor to ceiling heights.

3.1.2.15 Transitions are described in the direction of air flow. For converging transitions, use a maximum slope of 1 in 4 and, for diverging transitions, use a maximum slope of 1 in 6.

3.1.2.16 Paint interior of ductwork for at least 610 mm (24") behind supply, return and exhaust grilles and registers with matte black paint so as to render ductwork invisible from occupied space. Do not paint ductwork which is internally lined. Ensure that paint is water based and VOC content does not exceed the limits listed in Section 01 67 11, Material and Product Requirements.

3.1.2.17 Apply one coat zinc chromate primer over all welded surfaces. Ensure that primer VOC content does not exceed the limits listed in Section 01 67 11, Material and Product Requirements.

3.1.2.18 If there is a conflict between the duct sizes shown on the floor plans and the duct sizes shown on sections, elevations or details, the floor plans will govern.

3.1.2.19 Seal all transverse joints, longitudinal seams and duct wall penetrations to SMACNA Seal Class A standards.

3.1.2.20 Install duct smoke detectors supplied by Division 26.

3.1.3 **Low Pressure - Rectangular Ductwork**

3.1.3.1 Fabricate and install according to current SMACNA standards. Use 2 W.G. pressure class. Use SMACNA recommended sheet metal thicknesses. Fabricate with all flat surfaces wider than 450 mm (18") either cross broken or transverse beaded, regardless of whether the duct is insulated, lined or bare.

3.1.3.2 Use elbows in the following order of preference:

3.1.3.2.1 Full radius elbows with inside radius equal to duct width.

3.1.3.2.2 Square elbows with turning vanes.

3.1.3.3 Provide extended handles in insulated ductwork so insulation can be 100% sealed behind handle. Provide balancing dampers where indicated on the Drawings, and as specified below:

3.1.3.3.1 Install balancing dampers at locations in return, exhaust and low pressure supply ductwork where main ducts are split into two or more branches. Locate one damper in each branch.

3.1.3.3.2 Install a balancing damper at each branch fitting takeoff to a single diffuser, grille or register.

3.1.3.3.3 Provide balancing dampers where specified, indicated on the Drawings and at any other locations required by the Testing and Balancing Contractor.

3.1.4 **Round and Flat Oval Ductwork**

3.1.4.1.1 Provide a decorative grade installation where ductwork is exposed to view, outside of Mechanical Rooms. Use satin coat finish, degreased and suitable for field painting without etching duct surfaces.

3.1.4.1.2 Make all joints in ductwork exposed to view using “Spiralmate” round duct connector system or equivalent.

3.1.4.1.3 Rotate spiral seams on duct-to-duct joints so that the seam provides a continuous helical pattern across the joint.

3.1.4.1.4 Fasten diffuser collars to duct using pop rivets. Provide a finishing filet of elastomer seal at the collar-duct junction.

3.1.4.1.5 Space hangers at equal intervals. Fasten hangers to duct system using ring collars as shown on the Drawings.

3.1.5 **Medium Pressure Ductwork**

3.1.5.1 Fabricate and install according to current SMACNA standards for 1490 Pa (6" W.G.) pressure class.

3.1.5.2 Provide transitions upstream of terminal volume boxes, maintaining at least four duct diameters of straight duct at box inlet.

3.2 **FLEXIBLE DUCTS**

3.2.1 Where not exposed to view, in lieu of the solid duct connections shown, flexible ducts may be used to connect variable volume terminal boxes to medium pressure duct system and to connect linear supply diffusers to supply duct plenums. In other spaces, flexible ducts may also be used to connect diffusers to duct runouts.

3.2.2 With the exception of diffuser runouts, the length of flexible duct must not exceed 600 mm (24") and only maximum 70 offsets (no elbows) will be permitted. Use hangers and supports to ensure this condition is maintained.

3.2.3 For diffuser runouts, the length of flexible duct must not exceed 1.8 m (6") and maximum one 90º elbow will be permitted. Use hangers and supports to ensure duct does not sag.

3.2.4 Make all duct connections using Duro-Dyne FT-2 high pressure fibreglass tape, sheet metal screws, and Duro-Dyne duct sealer. Installation to be UL Listed treatment as published by the manufacturer. Ensure that adhesives and sealer VOC content does not exceed the limits listed in Section 01 67 11, Material and Product Requirements.

3.3 **INTERNAL DUCT LINING**

3.3.1 Install lining in accordance with liner manufacturer's published recommendations and SMACNA “HVAC Duct Construction Standards - Metal and Flexible”. Use both adhesive and mechanical fasteners. Select pin lengths to limit insulation compression to 3 mm (1/8"). Butter butt joints with a fire resistant coating and extend 50 mm (2") on either side of joint to stop air from lifting insulation. Repair liner surface penetrations with adhesive meeting ASTM C919.

3.3.2 Internally line ducts where shown or noted on Drawings. Use 25 mm (1") thickness, unless designated otherwise.

3.4 **SMOKE AND FIRE DAMPERS**

3.4.1 Install fire dampers, smoke fire dampers and smoke dampers in strict accordance with the manufacturer’s installation instructions provided with each

damper, and arrange as shown on the Details on the Drawings. Dampers must be installed and labelled in accordance with NFPA 80-13 (fire dampers) or NFPA 105-13 (smoke dampers).

3.4.2 Smoke detector will be provided and installed by Electrical Trades. Wiring between detector and damper actuator will be provided and installed by Electrical Trades. Coordinate power and fire alarm wiring with Electrical Trades.

3.4.3 Section 23 30 00 is responsible for testing of smoke damper operation using test switch, prior to integrated systems testing by Division 26.

3.4.4 Upsize section of ductwork at damper, where required to suit minimum access door size of 12”x12”.

3.4.5 Install duct access door with viewport and safety chain for each SFD and SD immediately adjacent to factory sleeve. Location of access door to allow for observation and visual confirmation that damper closes upon smoke detection.

3.5 GRILLES, REGISTERS AND DIFFUSERS

3.5.1 Cooperate on the job with other trades so that grilles, registers and diffusers do not conflict with lights, etc. Bring any conflict between grilles, registers and diffusers and the work of other trades to the attention of the Consultant before any ductwork is installed. See Architect's reflected ceiling plan for location of grilles, registers and diffusers.

3.5.2 Install frame for each grille, register and diffuser to suit the type of building construction.

3.6 FLEXIBLE DUCT CONNECTORS

3.6.1 Make all duct connections to fans, fan cabinets and plenums with preassembled duct connectors. On all return air fans, fabricate an acoustic seal over flexible connectors.

3.7 TESTING AND BALANCING

3.7.1 Cooperate with the Testing and Balancing trade. See Section 23 05 93 “Testing, Adjusting and Balancing for HVAC”. Make any changes deemed necessary by the Testing and Balancing trade to permit proper testing and balancing of the systems.

3.7.2 Provide additional balancing dampers where required by the Testing and Balancing Company.

3.7.3 Be responsible for the initial alignment and tension of all fan pulleys and belts.

3.7.4 Provide any changes to fan drives, pulleys and belts as required to allow a proper air balance as recommended by the Testing and Balancing Company for equipment supplied under this Contract.

END OF SECTION

1 General

1.1 **GENERAL REQUIREMENTS**

1.1.1 Conform to the requirements of Division 21 05 01 “Common Work Results for Mechanical”.

1.2 **SHOP DRAWINGS**

1.2.1 Submit Shop Drawings in accordance with Section 21 05 01, “Common Work Results for Mechanical”, Clause “Shop Drawings”, for the following equipment and materials:

- Air Terminal Units
- Fan Coil Units
- Forced Flow Heaters
- Wall Fin Convectors

2 Products

2.1 **MATERIALS**

2.1.1 Use materials specified herein or approved equal as defined in Section 21 05 01, “Common Work Results for Mechanical”, Clause “Material and Equipment”.

2.2 **VAV AIR TERMINAL UNITS**

2.2.1 Use E.H. Price Limited SDV-5000 single duct variable air volume control assemblies. See Equipment Schedule for sizes and capacities. Include optional removable flow measuring sensor so that sensor can be removed and cleaned.

2.2.2 Construct boxes of minimum 22 gauge galvanized steel. Line boxes with 20 mm (3/4") thick, fibre free foam.

2.2.3 Provide 3 ft long discharge sound attenuator, sized to match terminal unit outlet, with each unit. Construction to match terminal unit.

2.2.4 Use assemblies which are pressure independent and capable of being easily reset to any airflow between 0 and maximum. With inlet velocity of 10 m/s (2000 fpm), the basic box differential static pressure must not exceed 37 Pa (0.15" W.G.). With an attenuator, the static pressure across the assembly with an inlet velocity of 10 m/s (2000 fpm) must not exceed 112 Pa (0.45" W.G.). Include an acoustic vortex shredder for noise control. Use dampers with gasket stops and leakage less than 2% of rated air flow at 750 Pa (3" W.G.) inlet static pressure.

2.2.5 The terminal unit controllers and damper actuators will be supplied by Section 25 00 00 “Controls” and field installed on the units.

2.2.6 Where shown or designated on the Drawings, provide electric reheat coil mounted in enclosure with access door. Size enclosure to match terminal unit outlet. Use coils with capacities as detailed in Equipment Schedule. Coils to include SCR modulating controller with terminals for BAS enable and output control, as well as airflow proving switch and thermal cutout safeties.

2.2.7 Submit unit discharge sound power level data and casing radiation sound power level data for each size box to Consultant when submitting Shop Drawings.

2.2.8 The following manufacturers of the above equipment will be considered equal, subject to requirements of Clause “Material and Equipment”:

Anemostat
Kreuger
Nailor
Titus
Tuttle and Bailey

2.3 WALL-FIN CONVECTORS AND REPLACEMENT CONVECTOR COVERS

2.3.1 Use Sigma wallfin convectors and convector covers. Refer to the Equipment Schedule on the Drawings for model, configuration, capacities, and details.

2.3.2 Use minimum 16 gauge steel enclosures with proper bracing and support for enclosures and elements. Provide removable enclosures, with all necessary trim pieces and end pieces, lengths and configuration to suit the arrangement shown on the Drawings. Coat casings with baked on primer. Finish exterior surfaces with baked on enamel of Architect’s choice from standard colour chart (minimum 4 colour choices).

2.3.3 Use Sigma model 44C125, 102 mm x 102 mm (4" x 4") aluminum fins on 32 mm (1-1/4") seamless copper tube, 157 fins per metre (48 fins per foot). Use 460 mm (18") high, sloped top, open bottom inlet, stamped top outlet configuration unless shown otherwise on the Equipment Schedule.

2.3.4 The following manufacturers of the above equipment will be considered equal, subject to requirements of Clause “Material and Equipment”:

Engineered Air
Rittling
Sterling
Trane

2.4 FORCE FLOW HEATERS

2.4.1 Use Sigma Model SFF force flow cabinet unit heaters. Refer to Equipment Schedule for configuration, capacities, and details.

2.4.2 Use cabinets suitable for mounting arrangements indicated in Schedule. Equip cabinets with return and discharge grilles to suit unit arrangement and installation. Provide free standing pedestal units where indicated.

2.4.3 Use horizontally mounted, 3 row coils consisting of 12 mm (1/2") outside diameter copper tubes expanded into aluminum fins for a durable mechanical bond. Minimum working pressure of 1030 kPa (150 psi). Mount in cabinets with provision for thermal expansion.

2.4.4 Provide units complete with twin DWDI forward curved fans mounted to a double shafted PSC motor. Equip units with 25 mm (1") thickness MERV 8 pleated type filter. Provide a spare set of filters with each unit.

2.4.5 Provide cabinet enclosure fabricated from 16 gauge steel coated inside and out with baked on primer. Finish exterior surfaces with baked on enamel of a custom colour, matched to a colour chip provided by the Architect.

2.4.6 Provide a motor speed controller with on/off switch. Mount controller inside unit for wall-mounted types. For ceiling applications, provide a separate starter suitable for remote, recessed, wall installation.

2.4.7 The following manufacturers of the above equipment will be considered equal, subject to requirements of Clause “Material and Equipment”:

Engineered Air
Rittling
Sterling
Trane

2.5 CHILLED WATER FAN COIL UNIT

2.5.1 Use Daikin “ThinLine” or “PreciseLine” horizontal fan coil units. Each unit to be ARI certified. Capacities and details per Schedule on Drawings.

2.5.2 **General**: Basic unit to consist of a base casing fabricated of heavy gauge galvanized steel. Unit casing to be double wall foam panel construction with solid inner galvanized steel liner suitable for exposed to view installation. Fibreglass insulated casing will also be acceptable, with solid inner galvanized steel liner. Powder coated finished cabinet of custom colour to be chosen by Architect. All units are to include filter frame and bottom service access to slide out fan assembly and coil section for maintenance purposes. Return and discharge air opening locations are to be configured as per Schedule on Drawings. For units with ducted discharge, supply unit with four-sided one inch duct collar for an easy connection to discharge duct work. For units with ducted return, supply unit with 20 mm (3/4") return air duct collar. For units with bottom discharge or return, provide unit with stamped double deflection grille.

2.5.3 **Electrical**: Unit to be furnished with a single point power location, terminal strip and junction box for motor and other electrical terminations.

2.5.4 **Coils**: Use copper coils with aluminum fins mechanically bonded to the tubing. Braze tubes to supply and return headers and grade to achieve gravity drainage. Test coils to 2590 kPa (375 psig) pressure and mount in casings with provision for thermal expansion. Provide stainless steel coil casings and stainless steel drain pan.

2.5.5 **Fan Assembly**: Unit fan(s) to be direct driven, forward curved, double width, double inlet scroll centrifugal type constructed of galvanized steel, with premium efficiency ECM motor. PSC motors will not be accepted.

2.5.6 **Filters**: Provide 50 mm (2") MERV 13 filters. Include a spare set of filters.

2.5.7 **Controls**: Provide a terminal strip to allow BAS to stop and start the fan.

2.5.8 The following manufacturers will be considered equal, subject to requirements of Clause “Material and Equipment”:

Carrier
Engineered Air
Trane

3 Execution

3.1 **FORCE FLOW HEATERS, CONVECTORS AND FAN COIL UNITS**

3.1.1 Make connections to elements with brass seated unions. Install a shutoff valve on each supply, and a shutoff valve and a balancing valve on each return. Locate control valves above accessible ceilings or behind access doors.

END OF SECTION

1 General

1.1 **GENERAL REQUIREMENTS**

1.1.1 Conform to the requirements of Section 21 05 01 “Common Work Results for Mechanical”.

1.1.2 Conform to the requirements of “Brock University Design Standards Section 25 00 00 through 25 90 00.

1.2 **SCOPE OF WORK**

1.2.1 Provide an electronic/electric, direct digital control (DDC) Building Automation System to make the new or modified mechanical and electrical systems controls completely operational. Connect to and extend the existing BAS.

1.2.2 Provide new controls work for all new mechanical equipment and systems.

1.2.3 BAS contractor to provide all network drops required to complete the BAS installation. Extend network connection(s) from the nearest IT/Communications Closet; coordinate this activity with the Electrical/Communications contractor.

1.2.4 Supply for installation by others, the following:

- control valves

1.2.5 The Controls Subcontractor is to be responsible for arranging, coordinating and supervising the installation of the above devices in a suitable manner and location.

1.2.6 Wire components of control system in accordance with the requirements of Division 26. Include wiring between control components and electrical circuits of fans, pumps, and any other equipment or apparatus as indicated in this section or required for the proper functioning of controls as described in this section. Provide necessary transformers, relays, etc. to accomplish specified control function. All controls provided by this Section to be wired by this Section.

1.2.7 For each controller, choose a unit that will provide a minimum of 10% spare points of the total available points, for each type of point, for future use. If these additional points necessitate the installation of an expansion module for the controller, which will otherwise not include any connected points, seek Consultant’s direction and provide expansion modules where directed by Consultant.

1.2.8 Controls Contractor must attend site meetings twice monthly to review progress of the work for the construction period 5 months prior to substantial completion through to the completion of the project.

1.2.9 Fully commission all work of this Section.

1.3 MANUFACTURER/INSTALLER CERTIFICATION

1.3.1 Use only one of the controls contracting firms listed below:

Ainsworth
BGIS Integrated Technical Services Canada Ltd
HTS Engineering

1.3.2 The work of this project is to be performed only by skilled factory-trained technicians under the direction of experienced engineers, all of whom shall be properly trained and qualified for this work and who are employed directly by the firms listed above.

1.4 SHOP DRAWINGS, MAINTENANCE DATA AND DOCUMENTATION

1.4.1 Direct Digital Control System Hardware

1.4.1.1 A complete bill of materials of equipment to be used indicating quality, manufacturer, model number, and other relevant technical data.

1.4.1.2 Manufacturer's description and technical data, such as performance curves, product specification sheets, and installation/maintenance instructions for the items listed below and other relevant items not listed below:

Direct Digital Controller (Controller panels)
Transducers/Transmitters
Sensors (Including Accuracy Data)
Actuators
Valves
Switches

1.4.1.3 Wiring Diagrams and layouts for each control panel. Show all termination numbers.

1.4.1.4 Schematic diagrams for all field sensors and controllers. Provide floor plans of all sensor locations and control hardware.

1.4.1.5 All graphics and equipment labelling shall be consistent with Brock Standards and shall be submitted accordingly in the shop drawing submission.

1.4.2 **Central System Hardware and Software**

1.4.2.1 Complete Bill of material and equipment used, indicating quantity, manufacturer, model number, and other relevant technical data.

1.4.2.2 Schematic Diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers model numbers and functions. Show all interface wiring to the control system.

1.4.2.3 Riser diagrams of wiring between central control unit and all control panels.

1.4.2.4 Identify port requirements so that port capacity issues can be addressed.

1.4.3 **Controlled Systems**

1.4.3.1 A complete description of the operation of the control system, including sequences of operation. The description shall include a reference to a schematic diagram of the controlled system.

1.4.3.2 A point list for each system controller including both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, and the location of the I/O device. Software flag points, alarm points, etc.

1.4.4 **Maintenance Data**

1.4.4.1 In addition to requirements specified in 21 05 01 “Common Work Results for Mechanical”, upon completion of the work, the control manufacturer shall provide three sets of Maintenance Data to the Mechanical Contractor for inclusion in Project Maintenance Manuals and affix a fourth, plastic coated set near or at the appropriate control panel. Maintenance Data to include the following:

1.4.4.2 Copies of the complete, approved, Shop Drawings.

1.4.4.3 Copy of the Electrical Safety Final Inspection Certificate.

1.4.4.4 Project Record Drawings.

1.4.4.5 Update the University’s master control schematic.

1.4.4.6 As-built versions of the submittal Shop Drawings.

1.4.4.7 Operations Manual with procedures for operating the control systems, including logging on/off, alarm handling, producing point reports, trending data, overriding computer control, and changing set points and other variables.

1.4.4.8 Licences, guarantees, and warranty documents for all equipment and systems.

1.5 ACCEPTANCE PROCEDURES

1.5.1 Upon completion of the work, the Control Contractor shall coordinate with the Testing and Balancing Contractor, Commissioning Agent and the Owner's forces for final commissioning. A complete operational system as specified must be delivered to the Owner for final acceptance.

1.5.2 Instruct the Owner's operating personnel as to the intended operation of all control equipment and proper maintenance procedures as part of Section 21 05 01.

1.6 TRAINING

1.6.1 Provide complete instructions to the Owner's designated representatives for proper control of the system under all modes of operation including but not limited to summer/winter, occupied/unoccupied, energy management and alarm event sequences. Give special attention to resetting of heating/cooling setpoints.

1.6.2 Provide a User's Guide with information on the general operation of installed system. In addition, provide a Programming Reference including detailed information regarding program entries made for the various functions of the control system. Supply three copies of each and utilize in the operator's training curriculum.

1.6.3 Operator training is to consist of both on site hands-on training and classroom training. Allow for three days of classroom training and two other days of training at a minimum.

1.7 WARRANTY

1.7.1 All controls, equipment and material to be unconditionally warranted for a period of one year from the date of acceptance by the Owner. The warranty period is to commence when the building is turned over for occupancy.

1.7.2 Provide warranty service at no cost to the Owner for the warranty period. This to include, but not limited to the following:

- Emergency repair service on regular working hour basis during warranty.
- Replacing defective parts and components as required.
- Servicing by factory trained and employed service representatives of system manufacturer.

1.8 **LICENSES AND OWNERSHIP**

1.8.1 Ownership of, and licences for, all hardware and software originally installed or required for ongoing system operation, maintenance and modification to be registered, without restrictions, in Owner's name.

1.8.2 Licensing to permit an unlimited number of users to access system without additional fees.

1.8.3 As of last month of the warranty period, software is to be upgraded to current version or release at no cost to the Owner.

2 Products

2.1 **GENERAL**

2.1.1 **Interfacing Standards**

2.1.1.1 Input/output devices to use ASCII (American Standard for Communication and Information Interchange) code and standard EIA (Electronic Industry Association) interfaces.

2.1.1.2 CSA T530: Building Facilities, Design Guidelines for Telecommunications (same as EIA/TIA 569).

2.1.1.3 IEEE 802.3 Ethernet 10Base-T LAN.

2.1.2 **Components and Equipment**

2.1.2.1 All Components and Equipment shall be designed and selected to provide the requisite level of function and performance when operating in following minimum ambient condition ranges:

2.1.2.2 Temperature: 0°to 40°C (32° to 104°F) for Indoor Installation / -30°to 40°C (-22° to 104°F) for outdoor Installation.

2.1.2.3 Relative Humidity: 10% to 90% non-condensing.

2.1.2.4 Withstand VHF, UHF, FM, AM or background RFI as generated by commercial or private, portable or fixed transmitters that meet regulatory codes.

2.1.2.5 All equipment, components& devices shall be designed to operate on an electrical power service rated at 120 VAC +/- 10%, 60 Hz nominal.

2.1.2.6 Components installed within Motor Control Devices to be designed to operate with transient electrical fields occurring within these devices

2.1.3 **Fibre Optic Cable**

2.1.3.1 Duplex 900 mm tight-buffer construction designed for intra-building environments.

2.1.3.2 UL listed sheath 50 micron/125 OM3 Fiber Optic Cable.

2.1.3.3 Field terminations made using SC/LCT type connectors with ceramic ferrules and metal bayonet latching bodies.

2.1.4 Routers and Bridges

2.1.4.1 Selected as Industry standard hardware

2.1.4.1.1 Central system to use an Ethernet Local Area Network (LAN) for communication.

2.1.4.1.2 Communication between central server and controllers to be IP.

2.1.4.1.3 Router to bridge IP and data link (ARCNET, BACnet, MS/TP, LON) to be used between controllers if required.

2.1.4.1.4 Router to use FLASH memory and allow firmware updates to be performed from remote work station.

2.1.5 **BAS Software**

2.1.5.1 System software to support alternate operating systems.

2.1.5.2 Software to be completely web based without need for interface/translation devices or need to load software individually on each computer.

2.1.5.3 System and software to permit remote access, for multiple users, through internet connections.

2.1.5.4 Graphic files to be created with use of graphics generation package furnished with system.

2.1.5.5 Software to support concurrent operation of multiple standard and non-standard protocols including but not limited to:

- BACnet
- MODBUS
- LONTalk
- OPC
- SNMP

2.1.5.6 Operator Interface designed to operate through standard desk top or lap top personal computers without requiring purchase of special software from BAS manufacturer.

2.1.5.7 Interface on these personal computers to be standard Web Browser by Microsoft, Internet Explorer.

2.1.5.8 System software to support automatic paging

2.2 BAS PANELS AND CABINETS

2.2.1 Install Building Control Units, Equipment Control Units, and Field Panels in cabinets.

2.2.2 Cabinets shall be mounted on a painted non-combustible backboard which is rigidly mounted to a wall or on a galvanized steel, floor mounted support frame.

- installation on ductwork, equipment, and locations subject to vibration is not acceptable
- cabinets for Terminal Equipment Controllers may be installed on the terminal equipment provided there is no vibration that could affect controller operation or calibration of control device(s).

2.2.3 Cabinets to be sized to accommodate 20% future I/O points.

2.2.4 Cabinet locations are to be coordinated with other trades and the general contractor.

2.2.5 No panels (except Terminal Equipment Controllers) shall be installed in the ceiling space or at an elevation inaccessible for normal & ready access from the finished floor.

2.3 WIRING, CONDUIT AND CABINETRY

2.3.1 General

2.3.1.1 All of the installation requirements, be they temporary or permanent, shall comply with the Canadian Electrical Code and all local and Provincial codes.

2.3.1.2 For future expansion purposes, the Contractor shall ensure that wires are available in all conduits to accommodate the addition of possible future points to maximum capability of panel.

2.3.1.3 The Contractor to supply, install and connect all conduits, boxes and wiring between the different components related to the Control System, including all required line voltage to the equipment. All power to be from appropriately sized dedicated circuits from the nearest electrical panel with space provided by the Contractor. Circuits to be identified inside each control panel and on Shop Drawings using the same code. Provide circuit breaker lock-offs and clearly mark breaker(s) with "BCS".

2.3.1.4 Coordinate electrical requirements with Electrical trade. Arrange and pay for any modifications necessary to complete the work of this Section.

2.3.1.5 Provide all control transformers including the transformers for the room controls.

2.3.1.6 Provide power wiring for all panels and connect to nearest emergency power panel.

2.3.1.7 If wiring picks up unwanted noise, correct problem by replacing or rerouting wire at no additional expense to the Owner.

2.3.1.8 Wiremold and/or Raceway may not be used unless specifically approved by the Consultant.

2.3.1.9 All conduit shall be supported at least every 1.525 m (5') and as per Ontario Electrical Safety Code. Supports shall also be located at all connectors along the length of the conduit.

2.3.1.10 In damp or weather exposed areas, the conduit and related equipment to be suitable for the application.

2.3.1.11 All conductors shall be continuous from device to panel.

2.3.1.12 High and low voltage wire shall not be run in the same conduit.

2.3.1.13 Sensor, power and control wiring shall be run in separate conduit.

2.3.1.14 Where wiring penetrates fire separation, use fire stop sealant to maintain fire wall ratings.

2.3.2 **BAS Wiring**

2.3.2.1 Wiring shall be installed in conduit, raceways and enclosures separated from other wiring. Wiring may be installed without conduit in the interstitial space above finished ceilings, provided the following conditions are met:

- wiring has a minimum rating of FT6; and
- interstitial ceiling space is within the room where final termination of wire will be made

2.3.2.2 Each run of communication wiring to be continuous length without splices.

2.3.2.3 Wiring within BCU's, ECU's and Field Panels (Cabinets) shall be installed in a plastic tray with a removable cover.

2.3.2.4 Wiring shall be terminated at field-removable, modular terminal strips.

2.3.2.5 Connections within cabinets and panels shall be done using terminals, wire nuts and Marr connections are not acceptable.

2.3.2.6 Wiring to field sensors shall not be daisy-chained. Should it become necessary to splice field wiring it shall be soldered and a 500mm (20in.) loop length is to be provided.

- wire nuts and Marr connections are not acceptable
- if soldering is not possible approved B-type crimp connectors are an acceptable alternative

2.3.3 **Conduit**

2.3.3.1 Use thin wall (EMT) conduit up to and including 32mm (1¼") size for exposed wiring up to 3 m (10 ft) above floor level

2.3.3.2 Use rigid galvanized steel conduit in locations accessible to public, subject to mechanical injury, or outdoors; and for conduit 40mm (1½") size and larger.

2.3.3.3 Conduit to be parallel with, or at right angles to, building walls, concealed within finished shafts, ceilings, and walls where possible. Route all conduit to clear beams, plates, footings, and structural members.

2.3.3.4 Use watertight compression fittings in exterior locations.

2.3.3.5 Provide watertight seals at penetrations through outside walls.

2.3.3.6 Conduits leaving a building to the outside shall be sealed internally to prevent moist air from being pulled through the conduits, condensing, and then the water freezing inside the conduit.

2.3.3.7 Empty or unused conduit openings and stubs to be plugged or capped with compatible fittings. Plugs or caps on conduit openings are to be maintained during construction.

2.3.3.8 Conduits travelling between separate pressure regime areas shall be sealed internally to prevent migration of air and odors.

2.3.3.9 Conduit to field sensors shall not be daisy chained.

2.3.4 **Flexible conduit**

2.3.4.1 Provide flexible conduit for the final conduit run to vibrating or rotating equipment so that vibration and equipment noise is not transmitted to the rigid conduit. Lengths minimum 450mm (18in.) / maximum 900mm (36in.).

2.3.4.2 Provide flexible conduit for the last 450mm (18 in.) of conduit runs to field sensors. A junction box / enclosure shall be provided for terminations.

2.3.4.3 Use waterproof flexible conduit to be provided where exposed to weather or in damp or wet locations.

2.3.4.4 Lightning arrester shall be provided according to manufacturer's recommendations between the communication cable and ground wherever cable enters or exits building.

2.3.5 **Power Supplies**

2.3.5.1 Where Essential Power is available in a building, all Tier I devices shall be fed off an Essential Power source.

2.3.5.2 Power supplies to all BCU’s and all ECU’s/Control Elements associated with equipment fed off an Essential Power source shall be extended from an Essential Power source, preferably the same Essential Power source feeding the equipemt in question.

- an On-Board UPS Power source with a minimum 12 hour battery life shall be provided withing each BCU & ECU.

2.3.5.3 Control transformers shall be UL listed

2.3.5.4 Line voltage units shall be CSA listed, provided with over-current protection in primary and secondary circuits, sized to limit connected loads to 80% of rated capacity.

2.3.6 **DC power supplies**

2.3.6.1 Output to match equipment current and voltage requirements

2.3.6.2 Units to be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation to be 1.0% line and load combined, with 100-microsecond response time for 50% load changes,

2.3.6.3 Units shall have built-in over-voltage and over-current protection and to be able to withstand 150% current overload for at least three seconds without trip-out or failure,

2.3.6.4 Units shall be capable of operation between 0°C and 50°C (32°F and 120°F). EM/RF to meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.

2.3.7 **Power Line Filtering**

2.3.7.1 Shall be provided to afford internal or external transient voltage and surge suppression for workstations and control modules.

2.3.7.2 Surge protection:

- dielectric strength of 1000 V minimum,
- response time of 10 nanoseconds or less,
- transverse mode noise attenuation of 65 dB or greater,
- common mode noise attenuation of 150 dB or greater at 40-100 Hz.

2.4 **IDENTIFICATION**

2.4.1 Point Object Numbering systems shall include the Building Number as a prefix to all object identifiers.

2.4.2 All Equipment shall be identified in accordance with the University's Identification Standards, Section 20 00 00 Pipe Labelling, and numbering convention. Equipment numbers are provided by the University.

2.4.3 All wires shall be tagged at both ends. The tagging shall identify the device a wire is connected to. Use of the point object name is an acceptable means of device identification.

2.4.4 All junction boxes shall be tagged "BAS" with a sequential number suffix.

2.4.5 Control Devices shall be labelled using a Blue Flag Tie-Marker, such as Nelco PT#N-9L (or equivalent). Labels shall be white or yellow with large black text.

2.4.6 All local alarm devices (lights, strobes, horns, etc.) shall be clearly labelled as to their purpose with an appropriately sized lamacoid plastic plate that is securely affixed so as to be visible and legible from the direction of normal approach.

2.4.7 Prior to fabrication, proposed alarm device labels (wording, size, colors) shall be presented for review/approval by the University.

2.5 NAMEPLATES

2.5.1 Identify each I/O device and panel with nameplate identifying the point descriptor using the approved naming convention approved by the Owner.

2.5.2 In addition to identification as described above, show “BCS” identification label for each piece of equipment with nameplate.

2.5.3 Index terminal strips and tag wires. Label exposed junction boxes including function and nature of service. Tag all wires within the junction boxes including purpose and nature of service.

2.5.4 Use self adhesive strip or clip on style plastic markers for wire tags. Secure tags to each individual wire at both ends.

2.6 PULL BOXES AND JUNCTION BOXES

2.6.1 All boxes to comply with the Canadian Electrical Code in reference to size, capacity, etc.

2.6.2 All boxes to be fabricated of galvanized metal, unless otherwise warranted.

2.6.3 A pull box to be located every 30 m. The Contractor is responsible for the location and for obtaining any required approvals from the Consultant.

2.6.4 In suspended ceilings, all boxes to be installed on the structure.

2.6.5 All boxes to be clearly marked with “BCS” as part of the energy management system.

2.7 CONTROL DEVICES

2.7.1 System Controllers

2.7.1.1 Use general purpose DDC Controllers which are minimum 16 bit microprocessor based with EPROM operating system. The devices are to be programmable and capable of performing extensive measuring, control and monitoring functions. In addition to functions required to provide specified operational sequences, include time scheduling, trending and alarm management features. As a backup, the controller is to store DDC programs and data files on non-volatile EEPROM or flash memory to allow additions and changes. Each controller is to have 30 day battery backed real-time clock. Each panel is to be provided with a socket for a Portable Operators Terminal (POT), and a port for ethernet based network communications at no less than 10 Mbps. Provide LEDs for continuous indication of all bus communications,

power, and operational status. All panel electronics are to be installed in NEMA enclosures.

2.7.2 **Unitary Controllers**

2.7.2.1 Provide a separate unitary controller for each major system including the heat exchangers and associated pumps, air handling systems and for each VAV terminal unit and as necessary for a complete, operational system.

2.7.2.2 Unitary DDC Controllers (UCs) are to be standalone EEPROM based, fully programmable, to perform the sequences specified, and with I/O selected for the application. Test the UCs and list under both UL916 for computing devices and UUKL smoke control applications. Use plated steel UC enclosures. Provide each UC with face-mounted LED type annunciation to continually display its operational mode; power, normal, or in an alarm state. Design each controller with on-board jacks for quick commissioning and troubleshooting with a portable programming tool.

2.7.2.3 Unitary controllers are to be supplied by the controls contractor and field mounted to the terminal unit.

2.7.3 **Automatic Control Valves and Operators**

2.7.3.1 Contractor is responsible for the selection of control valves whose entire characteristics are suitable for the required application, including sizing, pressure rating, flow co-efficient, flow characteristics, close-off rating, fail position and allowable leakage factor.

2.7.3.2 General requirements:

- Minimum resolution for all valves is 40:1
- Designed to close at a differential pressure of 40 psi, with an inlet pressure of 150 psi

2.7.4 Use Belimo or Honeywell ball style control valves which are not pressure independent. Use valves with stainless steel ball and stem and Teflon seals. Ensure that straight-through water valves are single seated with equal percentage flow characteristics.

2.7.4.1 Use 3-way valves which are linear for each port giving constant total flow. On valves 50 mm (2") and smaller, use screwed 1030 kPa (150 psig) bronze bodies. On valves 65 mm (2-1/2") and larger, use flanged 860 kPa (125 psig) cast iron bodies. Size valves based on maximum 21 kPa (3 psi) pressure drop.

2.7.4.2 Use Belimo or Honeywell proportional action actuators. Size actuators to control valves against the maximum pump pressure or dynamic closing pressure, whichever is greater. Provide spring returns so that the valves "fail safe" in normally open or closed position as dictated by freeze, fire, or other temperature protection. Fail in place valves without spring return will be acceptable for individual terminal heating unit (i.e. radiant heating panel, radiator, convector, etc) control valves only.

2.7.5 **Brock University General Requirements for Sensors**

2.7.5.1 Brock University Design Standards shall override any requirements listed below. Meet all requirements of Section 25 30 00 Controls and Instrumentation in Brock Design Standards, included at the end of this Section.

2.7.6 **Space Temperature Sensors**

2.7.6.1 Space temperature sensors in classrooms, labs, offices and other regularly occupied rooms to be equipped with LCD display and limited setpoint adjustment. Sensors are also to be equipped with pushbutton for occupancy override.

2.7.6.2 In change rooms, washrooms, corridors, vestibules, mechanical rooms and other regularly unoccupied rooms, use only Greystone blank stainless steel coverplate style sensors.

2.7.6.3 All space sensors are to be located away from any direct influence from air diffusers or areas affected by drafts.

2.7.6.4 Where new sensors are located on existing poured concrete walls, provide conduit and surface mount electrical box for each sensor. Wiring to be concealed within walls, for any other type of wall construction, new or existing.

2.7.7 **Temperature Sensors, Thermostats, Freezestats and Firestats**

2.7.7.1 Sensors to be k OHM thermistors, with a suitable range to match the application. For hot water loop use RTD sensors. The accuracy to be ± 0.2 C maximum. All temperature sensors shall be mounted in an enclosure suitable for the application.

2.7.7.2 Space sensors are to be located away from any direct influence from air diffusers or areas affected by drafts.

2.7.7.3 Sensor averaging elements are to be mounted in straight sections of duct, in serpentine fashion, equally spaced to provide adequate coverage of duct cross section to prevent stratification. Minimum length of sensor to be length plus width of duct cross section. Furthermore, sensor's installation must not present a safety hazard nor impede access to fan compartments.

2.7.7.4 All return and supply air temperatures to be sensed with duct-mounted sensors having a minimum probe length sufficient to reach the middle third of the duct space.

2.7.8 **Carbon Dioxide Sensors**: Use nondispersive infrared sensors, 0-2000 ppm range, ±3% of full scale non linearity, ±40 ppm accuracy at 72F, capable of field calibration. Output analog indication of carbon dioxide level to BCS. Use units without display. Provide outside sensor as a reference.

2.7.9 **Static Pressure Transmitter:** Setra Model MRG.

3 Execution

3.1 **GENERAL**

3.1.1 Use competent tradesmen regularly employed by the manufacturer of the control equipment to install control system.

3.1.2 Unless noted otherwise, mount all room sensors and thermostats at 1200 mm (47”) above floor.

3.1.3 All controls to be connected to emergency power system.

3.1.4 All conduit and wiring is to comply with requirements of Electrical trades and General Conditions.

3.1.5 Upon completion of the system, the control contractor shall coordinate with the Testing and Balancing Contractor and the Owner’s forces for final commissioning. A complete operational system as specified must be delivered to the Owner for final acceptance. Also conform to the requirements of Section 210501 “Common Work Results for Mechanical”.

3.1.6 All control components to be arranged such that on power failure all controls fail to the position that existed when failure occurred. Air handling unit dampers must fail as follows: Outside air inlet and exhaust air dampers closed. Control valves on air handling unit heating coils to fail open.

3.1.7 DDC controller to be mounted in same room as equipment being controlled. Where this is not practical, provide a communication interface at equipment location for communication to DDC panel.

3.1.8 Provide points list on inside of DDC panels.

3.1.9 Nomenclature in DDC programming to match Control Shop Drawing nomenclature. DDC panels to be labelled as per Shop Drawings.

3.1.10 Install labels at all duct-mounted devices including transmitters, controllers, gauges, etc. Similarly label manual switches, unless they are delivered with standard nameplates. Similarly label all devices installed on local panels. Use Brother P Touch label system or approved equal.

3.1.11 Provide all wiring from power supplies to valves, dampers, thermostats, sensors, etc., and all necessary control transformers and relays required for the control system. Fuse a minimum of one leg of the secondary side of all Class 2 transformers. Fuse maximum of 125% of transformer rating.

3.1.12 Do **not** use marrette type wire connectors for terminations to valves, damper actuators, etc. Use flex type terminal blocks for all terminations.

3.1.13 Provide a copy of all graphical interfaces to Consultant for review at completion of programming.

3.2 NAMEPLATES

3.2.1 Install nameplates at all duct mounted devices including transmitters, controllers, gauges, etc. Similarly label manual switches, unless they are delivered with standard nameplates.

3.3 CONTROL PANELS

3.3.1 Mount all equipment inside the cabinet. Mount a plasticized "as-built" control diagram for water system, complete with control piping and wiring layout, on the face of door section. Locate panels in main Mechanical Rooms. Do not locate in ceiling spaces.

3.4 ELECTRICAL WORK

3.4.1 Provide an installation which follows horizontal and perpendicular lines to fit into the layout of the area. Properly support and install in a neat and workmanlike manner throughout. Conceal wiring in all finished areas.

3.4.2 All conduit and wiring is to comply with requirements of Division 26 and General Conditions.

3.4.3 Provide all wiring from power supplies to valves, dampers, thermostats, sensors, etc., and all necessary control transformers and relays required for the control system. Provide power from nearest panel.

3.4.4 Coordinate electrical requirements with the electrical trade. Arrange and pay for any modifications necessary to complete the work of this section.

3.4.5 Provide all necessary control wiring for equipment provided by mechanical trades.

3.4.6 Install wiring in conduit or aluminum tray throughout the renovated area, as wiring will be intermittently exposed to view. Wire in accordance with Division 26 requirements.

3.5 DDC CONTROL SYSTEM

3.5.1 Vendor's representatives to install complete control system providing adjustment of all controlled systems.

3.5.2 Vendor's representatives to provide full startup, calibration and commissioning of complete system. Connect all mechanical equipment in accordance with the Specifications.

3.6 PERFORMANCE VERIFICATION

3.6.1 Provide verification check sheets for all new control points and all associated control sequences. This work must be done, submitted and approved by the consultant prior to the commissioning agent being engaged and final payment being released. The approved reports are to be included in the maintenance manuals.

3.6.2 Verification check sheets for each piece of equipment must contain list of all control points associated with this piece of equipment. Proper operation of each sensor, actuator, terminal unit, or any other control point must be confirmed in the field by direct observation (if possible) and through the graphical user interface. Each verification sheet must be dated and signed by controls contractor.

3.6.3 Setup and verify trends for all new equipment and all control points. Provide trend verification sheets and sample sheets indicating trended points for consultant’s approval

3.6.4 One month after these checks and commissioning are complete, setup a meeting with mechanical contractor, Owner and consultant to confirm the operation of all new equipment. At this meeting all trends will be reviewed and confirmed with the Owner. Prior to the meeting the Controls contractor will be required to provide trend graphs or numerical data in Excel spreadsheet form, for all monitored systems for the last month of operation. If numerical data is provided the date/time data must follow Excel formatting.

3.6.5 Controls contractor will be responsible for correcting of all deficiencies found during this process and will be required to submit trends to verify operation of all equipment after making corrections.

3.7 BROCK UNIVERSITY CONTROL SEQUENCES GENERAL REQUIREMENTS

3.7.1 Minimum Requirements

3.7.1.1 Occupied/Unoccupied mode schedule for terminal unit set-back controls.

3.7.1.2 Occupied/Unoccupied mode schedule and Occupancy sensors to control AHU(s) dedicated to an individual classroom.

3.7.1.3 Supply Air Temperature Reset based on Terminal Unit Damper Position (for VAV Systems) and Reheat Valve Position.

3.7.1.4 Mixed Air Temperature as a means of controlling Fresh Air Damper.

3.7.2 Mode Control

3.7.2.1 To prevent the various control components (valves and dampers) from competing with one another, they are operated in sequence (based on heating or cooling demand). This sequence is determined by a "mode"; various modes are described below. In each mode the PHT LL controller will always be active and will keep the heating valve from closing when the PHT is below its low limit setpoint. In each mode the MAT LL controller will be active and will close the dampers (even below the min fresh air setting) when the MAT is below its low limit setpoint.

3.7.2.2 **Mode 0: Shutdown**

- Fans will stop
- Dampers will close
- Cooling valves will close
- Humidity valves will close
- If outside air is colder than the MAT setpoint then the heating valve will modulate to control the MAT at the low limit setpoint, otherwise the heating valve will close.

3.7.2.3 **Mode 1: Startup**

- This mode is only necessary when it is cold outside otherwise the system will simply jump out of it and into one of the control modes.
- On 100%FA units the heating valve will fully open (on cold days) to preheat the coil before the fan starts (this is necessary since the coils may not respond fast enough when a cold PHT is detected and the unit will trip off on freezestat). Once the fan starts the heating valve will ramp down to the control point.
- On mixed air units the outside dampers will remain closed on cold days (to remove any residual heat that may have accumulated in the duct when it was off). After the morning warm-up the dampers will slowly ramp open to

the control point.
- After the morning warm-up period the system will switch out of startup mode.

3.7.2.4 **Mode 2: Damper**

- The heating coil will modulate to maintain the PHT LL setpoint.
- Cooling coil will be closed.
- Damper will modulate to maintain the SAT SP

3.7.2.5 **Mode 3: Heating**

- Cooling coil will be closed.
- Damper will be at minimum.
- The heating valve will modulate to maintain the SAT at setpoint.

3.7.2.6 **Mode 4: Face and Bypass Damper or Reheat**

- The damper will be at minimum position.
- The cooling coil will be closed.
- When this mode is active the heating valve will be open at least 75% and the damper will modulate the air around the coil. If the air is being all directed to the coil then the heating valve will ramp open further.

3.7.2.7 **Mode 5/6: Heating Stage 1 and Stage 2**

- The damper will be at minimum position.
- The cooling coil will be closed.
- This mode is used for on/off heating stages (gas or electric).

3.7.2.8 **Mode 7: Cooling**

- The damper will be at maximum (economizer/enthalpy control may close this to minimum position).
- Heating valve will be closed (PHT LL always active).
- The cooling coil will modulate to maintain the SAT at setpoint.

3.7.2.9 **Mode 8/9: DX Stage 1 and Stage 2**

- The damper will be at maximum (economizer/enthalpy control may close this to minimum position).
- Heating valve will be closed (PHT LL always active).

3.7.2.10 **Mode10: Dehumidification**

- This mode is rarely used (it requires a cooling coil before a reheat coil).
- If a temperature sensor is installed after the cooling coil then the coil will be modulated to maintain the coil discharge temperature at the dew point. If no temperature sensor is installed after the cooling coil then the coil will be 100% open.
- The reheat coil will be used to maintain the SAT at its setpoint.

3.7.3 **Mixed Air Handling Units**

3.7.3.1 To prevent a large inrush current draw the fans across the campus are staggered using a pre-determined time delay calculated by the University.

3.7.3.2 Lag fans (when controlled by the automation system) will start 5 seconds after the lead fan.

3.7.3.3 When the unit is off, the dampers will be closed and the heating valve will be used to maintain the MAT at its low limit setpoint (cold side of the coil). If the outside air temperature is below the MAT LL SP then a morning warmup flag will be enabled.

3.7.3.4 On system startup, if the morning warmup is enabled then the dampers will remain closed during the warmup period. Once the warmup period is over the dampers will ramp open to their control point.

3.7.3.5 The system will operate according to the "Mode Control" as outlined above.

3.7.4 **Variable Air Volume Units (VAV’s)**

3.7.4.1 VAV's will maintain space temperature by adjusting the volume of air into the space while keeping it between an operator adjustable minimum and maximum volume.

3.7.4.2 If a reheat coil is installed then a discharge temperature sensor after the coil must be provided to identify any leaking valve.

3.7.4.3 If the space temperature is below the setpoint then the VAV will switch to reheat mode in which case the volume of air will increase to a heating setpoint (minimum air volume may be too little to allow the warm air from reaching the occupants); this is typically 10% of the span between minimum and maximum and then added to the minimum.

3.7.4.4 A demand limit variable is generated which can be used by the AHU to adjust the duct pressure and supply air temperature (we can't just use the space temperature and setpoint since we won't be able to determine if the VAV had more capacity to satisfy the space temperature). A value of 0% indicates the AHU should increase the supply air temperature while a value of 100% indicates that the temperature should be lowered. The AHU will only use this information if it has feedback from most of the spaces it affects.

3.8 BROCK UNIVERSITY BAS GRAPHIC GENERAL REQUIREMENTS

3.8.1 At a minimum BAS graphics shall display the following:

- Facility Site Graphic
- Individual Graphics for each System
- Terminal Units & Equipment Floor Plan
- Room Number and Area designation for each Terminal Unit & piece of Equipment

3.8.1.1 Also include a Main Page in Tabular Format displaying, as applicable, the following information for each piece of equipment/system

- Command Status
- State Status
- Current Setpoints
- Current Speed
- Current Temperatures
- Alarm Condition, if any, displayed in a different color
- Alarms to be assigned a Priority Ranking and include Descriptor identifying relevant equipment and its location. (eg. E1 BLDG 040 P4 Condensate Pump failed to start <Room 008>)
- Area served by Equipment/System with a link to the individual graphic that equipment/system

3.8.2 Graphics shall be developed using a standard library of image files and industry standard symbols.

3.8.3 Controls graphics on all projects to include the creation of mobile viewing platform approved by the University.

3.8.4 **Air Handling Units**

3.8.4.1 At a minimum instrumentation shall be provided at each Air Handling Unit to monitor the following:

- Outside Air Temperature (may be common to a building)
- Return Air Temperature
- Mixed Air Temperature
- Filter Pressure Drop across each bank of filters
- Air Temperature Upstream & Downstream of all Coils
- Supply Air Relative Humidity
- Supply Air Static Pressure
- Supply Air Flow
- Supply Fan Speed (where fan is equipped with a Variable Frequency Drive)
- Return Air Relative Humidity
- Return Fan Speed (where fan is equipped with a Variable Frequency Drive)
- Return Air CO2 sensor

3.8.5 **Heating & Cooling Coils**

3.8.5.1 A water temperature sensor shall be provided on the inlet and outlet of each coil installed within an air handling unit.

3.8.5.2 An air temperature sensor shall be provided upstream and downstream of each coil installed within an air handling unit.

3.8.6 **Reheat Coils & VAV Boxes**

3.8.6.1 An air temperature sensor shall be provided downstream of each reheat coil.

3.8.6.2 Air temperature sensors shall be provided such that the discharge temperature of each VAV can be measured.

3.8.7 **Terminal Units**

3.8.7.1 Terminal units shall be equipped with an Air-flow Monitoring device interfaced with the BAS.

3.9 **BROCK UNIVERSITY BAS ALARM GENERAL REQUIREMENTS**

3.9.1 The BAS system shall be complete with all alarming required for proper operation of the equipment and systems.

3.9.2 All time delays and alarm thresholds shall be adjustable via the software, not via the BAS graphics.

3.9.3 Alarms shall include any specific alarms required for specialized applications.

3.9.4 At a minimum the following alarms are to be provided:

3.9.4.1 **High Priority - Critical Alarms:**

- High-high level for all condensate tanks, sump pits, or any other application where a flood will occur if the high-high level is surpassed.
- High CO2 level (when CO2 sensor(s) are utilized).
- Any high or low limit alarm on mechanical systems..
- Freeze Stat tripping off, need manual reset.
- Positive and negative pressures exceeded in critical areas (e.g. Labs).
- Elevator failure.
- Fire Alarms - Trouble, Supervisory and Alarm.
- Generator and Life Safety - ATS Switchover.
- UPS Failure.
- High Voltage Switch - Trip Alarm (Open or Close)
- BAS Communication failure.
- All equipment alarming for:
  - Boilers
  - Compressors
  - Pumps
  - Air Handling Units
  - Chillers
  - Cooling Towers
  - Domestic Hot Water Tanks and Boilers
  - Fan Units
  - Engines

3.9.4.2 **Medium Priority - Moderate Alarms:**

- Motor not started after commanded on,
  - Applies to all motors (pumps, fans, etc.).
- Motor not stopped after commanded off,
  - Applies to all motors (pumps, fans, etc.).
- High and low static pressure alarms (pumps, fans, ducts, etc.).
- Minimum and maximum damper positions when exceeded.
- Equipment out of range, all equipment (speed, amps, temperature and Pressure).
- Set point exceeded - Hot Water Heating, Domestic Hot Water, Glycol and Chilled Water systems.
- Transformer high temperature.

3.9.4.3 **Low Priority - Low Alarms:**

- Differential pressure across filter bank exceeds 250pa.
- High supply humidity level in supply air duct.
- High duct temperature.
- Supply and return fan current sensor.
- Exhaust fan failure in critical areas (ie. IT, Boiler Room, Electrical Room).
- Supply air temperatures more than 5˚C from setpoint for more than 10 minutes.
- Space temperature out of range (humidity, temperature, pressure).
- Converter/Heat exchanger temperatures more than 10˚C from setpoint for more than 10 minutes.

3.10 EXISTING AIR SYSTEM N1

3.10.1 Description and Objectives

3.10.1.1 This existing air system provides cooling and ventilation for the area it serves. Heating is provided separately by perimeter hydronic heaters. The system will be modified as part of the renovation project, to change from single zone, constant volume operation to multiple zone, variable air volume operation, in order to satisfy individual zone temperature control requirements and to reduce energy usage. The system is recirculating type.

3.10.1.2 Each zone served by this system will now be equipped with a VAV terminal unit, as well as a space temperature sensor to control the terminal unit and a carbon dioxide sensor to adjust the terminal unit minimum damper position to prevent overcooling the rooms when unoccupied, and to provide demand control of ventilation. Terminal units are not equipped with reheat coils.

3.10.1.3 Demand controlled ventilation is provided for spaces with high occupant density and variable occupancy. A carbon dioxide sensor will be used to reset the minimum VAV terminal unit airflow according to occupancy levels sensed, which will in turn increase or decrease the ventilation airflow to the space.

3.10.1.4 This air system will operate continuously during occupied hours, and will generally be off during unoccupied hours. The air system will cycle on during unoccupied hours only when required to maintain the unoccupied cooling temperature setpoint.

3.10.1.5 Variable speed drives will be added to the supply fan and return fan as part of the renovation project. The supply fan speed will be controlled from static pressure setpoint. Return fan speed will track the supply fan speed with adjustable offset.

3.10.1.6 The unit includes chilled water cooling, hot water heating and steam humidification.

3.10.1.7 Energy efficiency controls features for these systems include outside air damper minimum position reset with supply air volume, to prevent over-ventilation; system static pressure reset to prevent unnecessary fan energy use; and system supply air temperature reset to prevent unnecessary cooling.

3.10.2 **General**

3.10.2.1 Review existing control sequences, alarms, devices, and BAS graphics for the existing system. Revise existing control sequences and replace devices as outlined herein. All other sequences, alarms, devices, etc to be duplicated with new air handling unit controls – this specification is not intended to diminish existing performance or remove existing features in any way. Coordinate with Consultant as required.

3.10.3 **Control Devices**

3.10.3.1 Provide a new dedicated unitary controller for the air handling unit.

3.10.3.2 Connect to existing modulating outside air, exhaust air and return air damper actuators.

3.10.3.3 Provide new supply air discharge and return air dry bulb temperature sensors and relative humidity sensors. Provide new dry bulb mixed air temperature sensor, and new temperature sensor on leaving side of heating coil.

3.10.3.4 Connect to existing coil and humidifier control valves for modulating control. Connect to existing coil water temperature sensors. Reuse existing humidifier safeties including airflow proving switch and high limit humidity sensor.

3.10.3.5 Connect to new supply and return fan variable speed drives. Provide digital output to enable each drive. Provide analog output of fan speed. Monitor drive output and alarm status for each drive.

3.10.3.6 Provide a new dpdt freezestat on the upstream face of the air handling unit cooling coil.

3.10.3.7 Provide a new static pressure sensor in the supply air ductwork, location as shown on the Drawings.

3.10.4 **Schedule and Startup**

3.10.4.1 Schedule occupied/unoccupied operation of unit.

3.10.4.2 Operate unit continuously during occupied hours.

3.10.4.3 Cycle the unit as required to maintain unoccupied cooling temperature setpoints. Maintain minimum 2.5°C (5°F) deadband between heating and cooling setpoints, in accordance with ASHRAE 90.1 requirements.

3.10.4.4 Provide adaptive optimum start/stop sequence for unit.

3.10.5 **Occupied Mode Air Temperature Control**

3.10.5.1 Modulate the hot water heating coil control valve, economizer dampers, and chilled water cooling coil control valve in sequence, as required to maintain supply air discharge temperature setpoint.

3.10.5.2 The system supply air discharge temperature setpoint minimum is 13°C (55°F) (adjustable). Reset the discharge temperature setpoint upward until at least one air terminal unit is 75% open (adjustable). Maximum permitted supply air temperature during occupied hours is 27°C (80°F) (adjustable). Tune this control loop to change very slowly, so that priority is given to static pressure reset strategy specified below.

3.10.5.3 If return air relative humidity rises above 60%, override supply air temperature reset and maintain setpoint of 13°C (55°F). Indicate on the graphic that the unit is operating in dehumidification mode.

3.10.5.4 When return air relative humidity is less than 60%, enable use of outside air for cooling when the outside air enthalpy is less than return air. If return air relative humidity is 60% or higher, only allow economizer operation when outside air absolute humidity level (grains of water per lb of air) is less than return air absolute humidity level.

3.10.6 **Fan Speed Control**

3.10.6.1 Supply and return fans will be equipped with variable speed drives. Connect to the drives and vary the capacity of the supply air fan through the drive to maintain supply air pressure setpoint at every sensor.

3.10.6.2 Setpoints for static pressure sensors to be determined by the Testing and Balancing Contractor and to be adjustable from the graphic. Indicate the original setpoint permanently on the graphic.

3.10.6.3 Provide static pressure reset control for each system. Reset static pressure setpoint lower until at least one air terminal unit is 90% open (adjustable).

3.10.6.4 Modulate the return fan speeds to maintain a constant offset (adjustable) speed between the supply and return fans. Testing and balancing contractor to determine offset setpoint.

3.10.6.5 Allow the operator to override the static pressure setpoint from the graphic.

3.10.7 **Ventilation Control**

3.10.7.1 Reset the minimum outside air damper position with supply fan speed as follows:

3.10.7.1.1 Minimum ventilation airflow is 35% at 50% supply fan speed and 25% at 100% supply fan speed.

3.10.7.2 Testing and Balancing contractor will determine actual damper positions required to achieve the required minimum air volumes at each flow condition.

3.10.8 **Unoccupied Mode Air Temperature Control**

3.10.8.1 On a call for unoccupied cooling for any space served by the air system, cycle the air system fans with fully open return air dampers and fully closed outside and exhaust air dampers, with fan speeds of 30 Hz (adjustable).

3.10.8.2 On a call for cooling, output a cooling supply air discharge temperature setpoint of 13°C (55°F) (adjustable) when fans are operating. Modulate the chilled water cooling coil control valve as required to maintain supply air discharge temperature setpoint.

3.10.8.3 Override the heating coil control valve and operate the heating coil circulating pump to maintain a temperature of 10°C (50°F) (adjustable) at the mixed air temperature sensor at all times when the unit is off.

3.10.9 **Safeties and Miscellaneous Controls**

3.10.9.1 Hardwire the freezestat to both the supply fan starter and to the BAS. When temperature lower than 4.5°C (40°F) is sensed at the freezestat, stop the fans, which will in turn close the outside and exhaust air dampers and open the return air damper. Use the signal to the BAS to generate an alarm.

3.10.9.2 Use the supply air discharge temperature sensor as a low limit safety. After 5 minutes of run time (adjustable), stop the fans, close the dampers and alarm to BAS if supply air temperature falls below 4.5°C (40°F) (adjustable) or rises above 60°C (140°F) (adjustable).

3.10.9.3 Where existing heating coil leaving water temperature sensor is present and falls below 4.5°C (40°F) (adjustable), stop the fans, close the dampers and alarm to BAS.

3.10.9.4 Reimplement existing humidifier controls and setpoints, as well as any other existing control sequences or features not modified above.

3.10.9.5 Where existing filter differential pressure sensor is present, monitor differential pressure drop across each filter bank. Display filter pressure drop on graphic and alarm when pressure drop exceeds filter change setpoint.

3.10.10 **Graphic Display**: Provide graphic display of equipment internal components such as supply fan, return fan, coils, humidifier, etc. Display must include unit off/on command status, occupied/unoccupied status, supply fans status, exhaust fan status, supply air temperature, return air temperature, outside air temperature, space temperature(s), space temperature setpoints (cooling, occupied and unoccupied), stages of cooling commanded on, economizer dampers position, unit general alarm status, filter change indicator status (where applicable). Display must also include a unit specific summary of how unit is controlled.

3.11 VAV AIR TERMINAL UNITS

3.11.1 Control Devices

3.11.1.1 Provide a unitary controller for each air terminal unit.

3.11.1.2 Provide a space temperature sensor and modulating electric damper actuator for each unit. Field mount VAV terminal unit controls and damper actuator.

3.11.1.3 Provide space carbon dioxide sensor adjacent to temperature sensor where shown on the Drawings.

3.11.2 Provide new two-way control valves with spring open modulating actuators to replace existing control valves as shown on the drawings.

3.11.3 Terminal Units without Reheat Coils

3.11.3.1 On a call for cooling, modulate open damper from damper minimum position to damper maximum position, as required to maintain space temperature setpoint.

3.11.3.2 On a call for heating, modulate damper closed until minimum position is reached. Modulate perimeter heat as required to maintain space temperature setpoint, where applicable.

3.11.4 Miscellaneous Controls

3.11.4.1 Provide a 2.5°C (5°F) deadband between heating and cooling operation, as required by ASHRAE 90.1. Provide adjustable setpoints for both occupied and unoccupied hours.

3.11.4.2 During scheduled unoccupied hours when there is no call for heating or cooling, open dampers only if unoccupied cooling is required.

3.11.4.3 Where room occupancy sensor is present, start up as normal for scheduled occupied hours. If, after 30 minutes (adjustable), occupancy sensor doesn't indicate occupancy, revert to unoccupied control mode. During occupied mode operation if occupancy sensor indicates no occupancy for 30 minutes (adjustable), revert to unoccupied control mode.

3.11.4.4 Work with Testing and Balancing Contractor to field set terminal unit minimum and maximum airflow positions. Minimum and maximum airflow rates are shown on the Drawings. Indicate design minimum and maximum airflows on graphic for each terminal unit. Minimum and maximum positions to be easily adjustable from graphic.

3.11.4.5 Override the terminal unit air damper minimum position as required to maintain space carbon dioxide sensor setpoint of 900 ppm (adjustable). Program an annual maintenance alarm for the carbon dioxide sensor.

3.11.5 **Graphic Display**: Provide graphic display of air terminal unit and equipment internal components such as space temperature and setpoint, damper position, flow measuring sensor, reheat coil control valve, perimeter heater control valve, supply air temperature sensor, etc. Display must include all monitored and controlled functions, sensors, etc. Include a pull down tab with a unit specific summary of how the unit is controlled.

3.12 CHILLED WATER FAN COIL UNIT

3.12.1 Description and Objectives

3.12.1.1 Fan coil units are provided to cool utility spaces such as Mechanical and Electrical rooms and IT Closets.

3.12.1.2 Existing IT closet exhaust fan is to be operated as backup cooling.

3.12.2 Control Devices

3.12.2.1 Provide a unitary controller for each fan coil. Provide a space temperature sensor and supply air temperature sensor for each unit. Provide a current sensor for fan status. Provide a relay and connect to existing exhaust fan starter. Remove existing IT Closet temperature controls.

3.12.2.2 Provide a two-way chilled water coil control valve with modulating actuator.

3.12.3 Control Sequence

3.12.3.1 On a call for cooling, start the fan coil unit supply fan. After a suitable time delay, gradually modulate open the chilled water coil control valve, as required to maintain space temperature setpoint.

3.12.3.2 Cycle the fan coil unit supply fan as required to maintain space temperature setpoint.

3.12.4 **Safeties and Miscellaneous Controls**

3.12.4.1 Alarm to BAS on high or low space temperature, high or low supply air temperature, or fan failure. Operate the exhaust fan on failure of fan coil unit.

3.12.5 **Graphic Display**

3.12.5.1 Provide graphic display of fan coil unit, exhaust fan, temperature sensors, status points, etc. Display must include all monitored and controlled functions, sensors, etc, with all alarms shown and all setpoints easily adjustable.

3.13 FORCE FLOW HEATERS

3.13.1 Provide a space temperature sensor and a two way control valve with two position fail open electric actuator for each heater. Connect to fan starter. Conceal control valves above accessible ceilings.

3.13.2 Open the control valve on outside air temperature below 7.5°C (45°F) (adjustable). Above 7.5°C (45°F) OAT, control valve is closed, and fan is off, as required by ASHRAE 90.1. When outside air temperature is below 7.5°C (45°F), cycle the fan to maintain the space temperature setpoint.

3.14 WALL FIN CONVECTORS

3.14.1 Provide two-way control valve with spring open modulating actuator. Provide space temperature sensor. Modulate control valve as required to maintain space temperature setpoint.

3.15 REMOVAL OF REDUNDANT OR OBSOLETE CONTROLS

3.15.1 Existing BAS control equipment rendered redundant or obsolete by the installation of a new BAS system or component shall be removed to the greatest extent possible. This includes all redundant or obsolete pneumatic, electric, electronic, and DDC devices. Control drawings and graphics shall be updated accordingly.

3.15.2 Removal shall include the clean-up, removal, and proper termination of all existing pneumatic equipment (tubing, piping, panels, actuators, sensors, etc.), existing electronics (wiring, conduit, actuators, sensors) or existing DDC system (controllers, cabinets, sensors, relays, transformers, power supplies, etc.) no longer used by the BAS.

3.15.3 Ductwork or walls affected shall be patched and sealed or covered with a suitable wall plate.

3.15.4 Removal may require the re-piping or rewiring of existing BAS control equipment that is to remain.

3.15.5 Pneumatic tubing or piping that cannot be removed shall be suitably plugged to prevent air leakage. Crimping or folding of tubing/piping is not acceptable.

3.15.6 Wiring remaining shall be suitably terminated.

3.15.7 Removal shall occur immediately after commissioning of the new control system in the building is complete.

3.16 CONTROL SYSTEM ACCEPTANCE

3.16.1 A complete system check-out is required. Before starting this, provide a detailed step-by-step checkout plan.

3.16.2 Demonstrate to the Owner's satisfaction at job site, the methods, test gear and simulation equipment to be used in check-out of each part of control system. Demonstrate the actual hook-up of test gear, exercise of inputs, trouble isolation and correction technique, and final operation test of a typical remote panel. Owner may check the operation of all sensors, transducers with own equipment to ensure proper operation.

3.16.3 After completion of the check-out, make all necessary corrections and repeat the check. When the system is fully operational, demonstrate in full detail, all functions/indications to the Owner.

3.16.4 Submit a checkout list to the Owner documenting that each point has been checked and is operating satisfactorily. The check should include field wiring, relay operation and HAND/OFF/AUTO checkout.

3.17 TREND LOGS

3.17.1 Set up trend logs to continuously monitor critical parameters for each system. Consultant will assist in determining critical parameters.

END OF SECTION

1 General

1.1 **GENERAL PROVISIONS**

1.1.1 This Section and Division 1 - General Requirements apply to and govern the work of all Sections of Divisions 26, 27 and 28.

1.2 **VISITING SITE**

1.2.1 Visit the site and be familiar with working conditions and work involved before submitting Bids. **NO EXTRAS WILL BE GRANTED DUE TO LACK OF A THOROUGH PRELIMINARY INVESTIGATION.**

1.2.2 Remove and replace existing ceiling tiles to inspect ceiling for existing Mechanical, Electrical and Structural obstructions. Include cost of all necessary changes in Bid Price. No extras will be granted due to lack of a thorough preliminary investigation of accessible ceiling spaces.

1.3 **CONTRACT DRAWINGS**

1.3.1 Electrical Drawings show Electrical work only and are not intended to show Structural details, Mechanical details or Architectural features. Take building dimensions and details from Architectural or Structural Drawings or from job measurements only.

1.3.2 Electrical Drawings indicate only the general locations of equipment and outlets. Wiring requirements are shown diagrammatically. Responsibility for the detailed layout of equipment, outlets, raceways and wiring is part of the work of this Division. Specific outlet locations are detailed on elevations.

1.3.3 If shown, only the general location and route of conduit, cable trays and communication hooks are shown. Install all services neatly to conserve headroom. All conduit, cable trays and communication hooks are to be accessible after work by other trades is complete. Install all services parallel to building lines unless shown otherwise.

1.3.4 The Consultant reserves the right to revise the locations of equipment and outlets within any given room without altering the Contract Price provided Notice of Change is given prior to roughing-in.

1.3.5 In case of conflict between work of other trades and work of this Division, clarify the location of these items with the Consultant before roughing-in.

1.3.6 In the event of any discrepancies or ambiguity of any symbol, note, abbreviation, etc., used in this Specification or on the Contract Drawings, obtain clarification, in writing, from the Consultant prior to submitting Bid. No

allowance will be made for additional costs arising from failure to obtain proper clarification of conflicting information before Bid.

1.3.7 All dimensions and sizes are in SI units, Generally units are in millimetres. All exceptions to this are noted.

CONDUIT SIZES

Imperial (Inches)	½	¾	1	1-¼	1-½	2	2-½	3	3-½	4	4-½	5	6
S.I. (metric) (mm)	16	21	27	35	41	53	63	78	91	103	116	129	155

1.4 SHOP DRAWINGS

1.4.1 Submit Manufacturers' Shop Drawings, Electrical Wiring Diagrams and Control System Drawings to the Consultant. Provide title sheet for Shop Drawing submitted. Include project name, Shop Drawing item (including Specification paragraph reference) and approval stamps. The Consultant reserves the right to have samples submitted of any specified products.

1.4.2 Before submitting shop drawings, provide a complete list of shop drawings to be submitted in Microsoft Excel format. List all shop drawings and approximate date of submission.

1.4.3 Submit all shop drawings electronically in Adobe® Acrobat® PDF format. File attachments to an email must total no more than 5 MB and must be submitted unzipped. If multiple items are submitted in single PDF file, each individual piece of equipment must be “book marked” using equipment labels as per Design Drawings. All shop drawings submitted electronically must be checked and stamped by Contractor as specified below.

1.4.4 Catalogues, manuals or price lists will not be accepted as Shop Drawings. Before submission, check Shop Drawings, make necessary corrections, apply stamp “Checked and Certified Correct”, sign and date.

1.4.5 Submit one reviewed set of Shop Drawings with each set of Maintenance and Operating Instructions.

1.4.6 The review of Shop Drawings by Chorley + Bisset Ltd. is for the sole purpose of ascertaining conformance with the general design concept. This review does not mean that Chorley + Bisset Ltd. approves the detail design inherent

in the Shop Drawings, responsibility for which remains with the Contractor. Such review does 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 Construction and 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 subtrades.

1.4.7 The Contractor is to review each shop drawing and document the differences between the shop drawing submission and the description listed in the specification. If there are no differences listed, the Contractor implicitly declares the shop drawing meets all requirements of the Specification.

1.4.8 Ensure at least one copy of the reviewed Shop Drawings is kept on site at all times for reference.

1.4.9 Prepare all Drawings in SI units.

1.4.10 Shop Drawings to include the following:

1.4.10.1 Indicate details of construction, dimensions, capacities, weight and electrical performance characteristics of equipment or material.

1.4.10.2 Where applicable, include wiring, single line and schematic diagram including interconnect with work of other sections.

1.4.10.3 Include manufacturer's special installation instructions where applicable.

1.5 FIELD DRAWINGS

1.5.1 Submit, to the General Contractor, Drawings accurately showing all openings for busducts, conduits, etc. Drawings must include the size of openings and their locations by dimensions, including the location of the structural members framing these openings. Each trade will be responsible for detail layout of their own work.

1.5.2 Assume full responsibility for the detailed coordination of all Electrical work. Prepare Field Drawings to determine the exact location of each service. On these drawings, include all mechanical and electrical services, architectural features, and structural details. If a conflict becomes apparent after the installation of services, pay all costs associated with removing and reinstalling these services.

1.5.3 If the General Contractor separates the Communication, Security or similar work from the other work of Division 26, the General Contractor assumes full

responsibility for this coordination work including the preparation of the Field Drawings.

1.6 **AS-BUILT DRAWINGS**

1.6.1 The Contractor will be provided with Mechanical and Electrical Files used to produce the contract documents. The following digital formats were used and are to be maintained: AutoCAD, Revit, and PDF. The Contractor is to print Drawings from the PDF files provided.

1.6.2 Revise and maintain the prints as work progresses. Show all revisions, relocations and changes, to scale. Use colour markings. At the end of the project, provide a complete PDF red mark-up set of as-builts drawings to the Consultant for record purposes. Printed hard copies will not be accepted.

1.6.3 Contractor shall take as-built measurements, prior to backfill, of all buried Duct Bank(s) and conduits under floor slab. Show routing, depths and dimensions from fixed points on as-built drawings.

1.6.4 Transfer information from the marked prints to AutoCAD files and Revit model on a monthly basis to match the software that version the original files were created in. Have the marked prints and updated CAD/Revit prints on site for review by the Consultant at all times. Monthly draws will not be approved unless all changes have been shown.

1.6.5 Prior to testing, balancing and final commissioning, complete the transfer of marked prints to the AutoCAD files and Revit model. Fill in the Owner's equipment numbering system in the Schedules on the Drawings and on the plans where blank placeholder tags have been shown.

1.6.5.1 AutoCAD format files are to match exactly the layering system and symbology of the Consultant. Bind all external references.

1.6.5.2 Revit model will be completed as per the project Revit/BIM deliverable. If no deliverable is defined, minimally the "Sheets" included under the "02-Construction" subset in the model, should properly display the as-built condition. Bind/Insert all linked files in the Revit model.

1.6.5.3 **Revit/Bim Deliverable**

1.6.5.3.1 Model will not include engineering, analytics or systems symmetry functionality (i.e. defined or totally connected systems).

1.6.5.3.2 All engineering and manufacturer information contained in the model will only be considered correct for identification with regard to the corresponding specification and scheduling purposes.

1.6.5.3.3 MEP components should be modelled by the Contractor to be as close as possible to as-built conditions but must still produce an acceptable printed as-built document.

1.6.5.3.4 The "Sheets" included under the "02-Construction" subset in the model, should properly display the as-built condition.

1.6.5.3.5 MEP Model components (i.e. piping, conduit) may not be modelled the proper size but identified correctly.

1.6.5.3.6 MEP Model components will be represented properly on floor plans (i.e. symbology) but not necessarily in elevations.

1.6.5.3.7 MEP equipment and other items that are generally required for coordination among disciplines (i.e. ceiling components) will be included in the model (approximate size shown). Many services will be shown in schematic fashion (i.e., not necessarily at correct elevation or in exact position required).

1.6.5.3.8 Due to the schematic nature of many portions of the model, services are likely to conflict and clash with various other services and structure. In some cases this is intentional so that services display properly on sheets. The Consultant will not be responsible for providing to the Contractor a detailed, accurate or clash free model without compensation, as the Owner has not required or paid for this work to be done by the Consultant. In turn, the Consultant will not require the Contractor to provide a more detailed, accurate or clash free model for the project as-built documentation than was originally provided to the Contractor. Responsibility for creation of accurate Field Drawings and resolving minor interferences remains with the Contractor.

1.6.6 Mark Drawings "As-Built Drawings" and insert name and logo of Contractor. Submit one set of printed "As-Built Drawings" for review by the Consultant. Remove Engineers Stamp. Include Contractors name and Logo.

1.6.7 Submit completed As Built Drawings on disks in same digital data software program, and version as original contract documents. Also provide one set of printed Drawings with the Operating and Maintenance Manuals.

1.6.8 For the purposes of Contract payments, As Built Drawings will be assumed to have a value of $2,500.00. This will not be released until As Built Drawings have been accepted as complete and acceptable by the Consultant. This amount is in addition to the normal 10% holdback required by the Construction Lien Act, 2018.

1.7 SIMULTANEOUS PROJECTS

1.7.1 Other projects may be under construction simultaneously on this site during the course of this construction project. The Owner will not be the "constructor" as defined by The Ontario Health & Safety Act & Regulations. This Contractor is to maintain a separation between this project and all other Contractors, by time or space, as defined by The Ontario Health & Safety Act & Regulations.

1.8 CONFLICTS AND PRECEDENCE

1.8.1 Immediately upon discovery of any conflict, ambiguity, error or omission in the Contract Documents, request clarification in writing from Consultant prior to starting the work in questions.

1.8.2 Failure to give such written notice will constitute an irrevocable waiver and release of any claim for additional compensation or delays incurred.

1.8.3 Where work fails to conform to Contract Documents, as clarified by Consultant, promptly remove and replace such work as directed, without adjustment to Contract price.

1.9 FIRESTOPPING

1.9.1 Before starting any work on site, submit detailed Shop Drawings to the Consultant for review and comments. Include:

1.9.1.1 Manufacturer's technical product data and installation instructions for each specific type and location of penetration.

1.9.1.2 Certification that proposed firestopping materials and assemblies comply with CAN-ULC S115 (use latest standard) "Standard Method of Fire Test for Firestop Systems".

1.9.1.3 For each specific type and location of penetration, provide installation instructions from a recognized independent testing agency.

1.9.2 Mark penetration and system number types and locations on set of white prints and submit with shop drawings. At completion of project, transfer this information to As Built Drawings.

1.9.3 Comply with all requirements of Ontario Building Code Clause 3.1.9, "Building Services in Fire Separations and Fire Rated Assemblies".

1.10 MAINTENANCE AND OPERATING INSTRUCTIONS

1.10.1 For the Electrical work only, assemble three sets of equipment literature (cuts), operating instructions, maintenance instructions, voltage test results, certificate, other pertinent data and Letter of Warranty. Place in three ring binders, complete with index pages, indexing tabs and cover identification at front and side. Submit to Consultant for approval.

1.10.2 Make changes or submit additional information as required to obtain approval. Final Certificate of Completion will not be issued until the Consultant possesses three approved sets. Include copies of reviewed Shop Drawings and name and address of Spare Parts' Suppliers with manuals.

1.10.3 Provide two electronic copies of the maintenance and operating manual in Adobe Acrobat PDF format on a USB Drive and submit with the final version of manuals. Electronic copy of manual to be provided as one file formatted with bookmarks in accordance with the sections of the hard copy manuals. Do not include separate files in sub folders. Divide the maintenance manuals into sections which correspond with Specification Sections.

1.10.4 The following information is to be contained within the Sections:

1.10.4.1 **Section 1:** A list of names, addresses and telephone numbers of the Consultants, General Contractor and Electrical Contractor. Written warranty of the Electrical systems.

1.10.4.2 **Section 2:** Electrical Safety Authority Inspection Permit, Fire Alarm Verification Report and Certificate, Emergency Lighting Verification Letter.

1.10.4.3 **Remaining Sections - By Specification Section**

1.10.4.3.1 A list of names, addresses and telephone numbers of all suppliers. A copy of all reviewed Shop Drawings.

1.10.4.3.2 A complete and comprehensive maintenance and operating instructions details D (daily), W (weekly), M (monthly), SA (semi-annually), A (annually) for maintenance.

1.10.4.3.3 Copies of warranties.

1.10.4.3.4 Complete control diagrams, wiring diagrams and description of applicable control systems and the functioning of the system.

1.11 REGULATIONS AND PERMITS

1.11.1 Carry out the work in accordance with the latest editions of relevant codes, local bylaws, and requirements of local Authority Having Jurisdiction. Apply for and obtain permits and pay all fees. Consultant will submit Drawings to Electrical Safety Authority if required.

1.11.2 Enforce all prevailing Provincial and local safety regulations at all times. Abide by all Owner's safety and security policies and procedures and conform to all regulations of the current Occupational Health & Safety Act.

1.11.3 After completion of the work, furnish to Consultant a Certificate of Unconditional Approval from Inspecting Authorities.

1.12 MATERIAL AND EQUIPMENT

1.12.1 Where an item of material or any equipment is specifically identified by a manufacturer's trade name and/or catalogue number, make no substitution except as provided for in paragraphs 3, 4 and 5 below.

1.12.2 In the case of some items of equipment, one or more additional names of acceptable equal manufacturers are listed in the Clause describing an item or a group of items. The design, layout, space allocation, connection details, etc., are based on the products named first in the description of each item. The products named first in the description of each item establish the quality of manufacture and design standards for all other manufacturers of that item. The general approval indicated by listing the names of other manufacturers is subject to final review of Shop Drawings, performance data, test reports, production samples (if required) by Consultant, and equipment shipped to site. Ensure that the products used meet the requirements specified and as shown on the Contract Drawings.

1.12.3 Suppliers wishing to submit other items of equipment for approval as an equal to those specified must apply to the Consultant at least 8 working days before Bid closing date. Requests must be accompanied by complete description and technical data on the items proposed. Approval for substitution of equipment will only be given on the understanding that all details, accessories, features and performance meet the Specifications unless otherwise stated. Deviations from the Specifications must be stated in writing at time of application for approval.

1.12.4 Include in the Bid, the equipment named in the Specifications or approved as an equal as in paragraph 3 above. This will form the Base Bid. Any number of alternative bids, as defined below, may be included in addition to the Base Bid.

1.12.5 Items of equipment by Manufacturers not named in the Specifications may be offered as alternatives to the manufacturers named in the Specifications. The alternative proposals must be accompanied by full descriptive and technical data, together with the statement of amount of addition or deduction from the Base Bid, if the alternative is accepted. Prior approval by the Consultant is not required on items submitted as alternative bids.

1.12.6 After execution of the Contract, substitution of equipment will be considered only if equipment accepted cannot be delivered in time to complete the work in proper sequence, or if the manufacturer has stopped production of the accepted item. In such cases, requests for substitution must be accompanied by proof of equality and difference in price and delivery, in the form of Certified Quotations from Suppliers of both specified and proposed equipment. Credit any decrease in price involved in substitution to the Owner by reduction of the Contract Price. The Contractor will not be reimbursed for any such increase in price.

1.12.7 Where equipment other than the equipment used as a basis for design, layout and space allocation is used, produce and submit revised layouts of equipment, pipes, ducts, etc., in the areas affected. Submit these Drawings with the Shop Drawings. Failure to produce these Drawings is indication by the Contractor that they are not required and the original space allocations are adequate for the substituted equipment.

1.12.8 Name the Subcontractors and Manufacturers in the Bid as indicated in Clause “List of Electrical Subcontractors and Manufacturers”.

1.13 INTERPRETATION OF CONTRACT DOCUMENTS

1.13.1 The decision as to which trade provides required labour or materials rests solely with the Contractor. Extra payments will not be considered based on a difference in interpretation of the Contract Documents as to which trade involved provides materials or labour for specific items of work. The Consultant will not enter into such discussions.

1.14 SITE VISITS

1.14.1 The Electrical Contractor shall have an office representative (not site personnel) at each site meeting and deficiency review. Attendance at these meetings is mandatory.

1.15 PROGRESS DRAWS

1.15.1 Electrical Contractor shall review all supplier and subcontractor draws submitted to their office to ensure they are fair and reasonable for the amount

of work completed on site to date prior to submitting to the General Contractor. Electrical Contractor will be responsible for the validity of supplier and subcontractor draw claims.

1.16 **WARRANTY**

1.16.1 Warranty all workmanship, material and equipment supplied by Divisions 26, 27 and 28 for one year after Ready for Takeover except where specifically specified otherwise. Make good damage caused due to defects and workmanship.

1.16.2 Where equipment specified in Sections of Divisions 26, 27 and 28 to have an extended warranty period, e.g. five years, the first year of the warranty period will be governed by the terms and conditions of the warranty in the Contract Documents, and the remaining years of the warranty will be direct from the manufacturer and/or supplier to the Owner. Submit signed and dated copies of the extended warranties to the Consultant before applying for a Certificate of Substantial Performance of the Work.

1.17 **DIMENSIONS AND QUANTITIES**

1.17.1 Dimensions shown on Drawings are approximate. Verify dimensions by reference to Shop Drawings and field measurement.

1.17.2 Verify equipment access and coordinate with equipment supplier to ensure equipment can be physically transported to installation location. Under no circumstances will any claim be allowed for extra cost to disassemble and/or assemble equipment at the final location which will be considered as part of equipment installation.

1.17.3 Quantities or lengths indicated in any of the Contract Documents are approximate only and will not be held to gauge or limit the work. No adjustment to the Contract Price will be allowed to complete the work.

1.17.4 Provide labour, products and services specified, but not shown on Drawings and vice versa, and all other labour, products and services necessary for completion of the work.

1.17.5 Make any necessary changes or additions to routing of conduit, cables, cable trays, and the like to accommodate structural, mechanical and architectural conditions, without adjustment to Contract price.

1.17.6 Provide work in accordance with the approved Schedule to meet completion date and specified interim Schedules.

1.18 COOPERATION BETWEEN TRADES

1.18.1 Cooperate and coordinate with other trades as required for satisfactory and expeditious completion of work. Take field dimensions relative to work. Fabricate and erect work to suit field dimensions and field conditions. Pay cost of extra work caused by and make up time lost as result of failure to provide necessary cooperation information or items to be fixed to or built-in, in adequate time.

1.19 COOPERATE WITH OWNER'S STAFF

1.19.1 Maintain close cooperation with Owner's staff. The Owner will determine the times during which work may be carried out in certain areas. If the work cannot be completed in the allowed time, the Contractor may be required to clean up the area and finish the work at some future time.

1.19.2 Shutdowns will be scheduled during unoccupied times. Include any overtime wages due to conditions stipulated above in the Bid Price.

1.19.3 Provide seven day's minimum notice, in writing, prior to any interruptions of service or restriction of use of any service.

1.19.4 Provide all phase testing, as required, prior to disconnecting existing and connecting new to avoid damage to equipment.

1.19.5 The Owner's operations must take precedence over Contractors' operations at all times. Interruptions due to noise, drilling, etc., will not be allowed without Owner's prior approval.

1.19.6 Include any overtime wages due to conditions stipulated above in the Bid Price.

1.20 EXAMINATION OF DAMAGED DEVICES

1.20.1 Report all damaged, defective and non-functioning devices and equipment shown for reinstallation or relocation to the Consultant prior to removal and storage. All devices and equipment will be assumed to be fully functional unless reported otherwise prior to removal.

1.20.2 Devices and equipment damaged during removal, storage or reinstallation will be replaced at no cost to the Owner.

2 Products

2.1 **MATERIALS**

2.1.1 Use materials specified herein or approved equal as defined in Clause “Material and Equipment”.

2.2 **FIRESTOPPING**

2.2.1 Use only service penetration firestop components and assemblies tested in accordance with CAN.ULC S115 “Fire Tests of Firestop Systems” and listed in most recent ULC “List of Equipment and Materials” or by another recognized independent testing and certification agency acceptable to the Consultant.

2.2.2 All pipe insulation passing through the fire separation to be approved with the listing of the firestop system.

2.2.3 Fire stopping installers must be trained by the fire stopping manufacturer and be able to provide proof of training by providing Fit Level 1 certificate when requested, while working on site.

2.2.4 Pipe sleeves through fire separations requiring a rating are to be installed as per firestopping manufacturer's recommendations, as some firestopping manufacturers do not allow pipe sleeves within their approved system. Confirm pipe sleeve compatibility prior to starting work on site.

2.2.5 The following manufacturers of the above equipment will be considered equal subject to requirements of Clause "Material and Equipment":

STI

2.2.6 Where communications J hooks or cable trays are shown passing through rated walls, stop the cable tray & J hooks 300mm (12") from wall and provide thru-wall fitting in rated wall. Provide quantity as required to maintain cross-sectional area of cable tray, or minimum one fitting per communication row of J hooks. Thru-wall fitting to be STI EZPath Fire Rated Pathways suitable for use in plenum spaces and maintain one, two, three or four hour fire rating in drywall, concrete and block penetrations.

2.3 **ACCESS DOORS**

2.3.1 Access doors to be flush to edge of frame, concealed continuous hinge with screwdriver operated cam latch. Non fire-rated door construction to be minimum 14 gauge, with 16 gauge frame. Fire-rated door construction to be a minimum 20 gauge insulated door with 16 gauge frame. Insulation thickness to provide required rating.

2.3.2 Size doors to allow adequate operating/maintenance clearance for devices. Doors to be a minimum 600 mm x 600 mm (24" x 24") for body entry, and 300 mm x 300 mm (12" x 12") for hand entry, unless noted otherwise. Use the following access doors:

Masonry Walls	Acudor UF-5000
Drywall Walls	Acudor DW-5040
Drywall Ceilings	Acudor BP58, match ceiling thickness
Fire-Rated	Acudor FW-5050/FB-5060 to match fire separation
Wet Areas,	Acudor UF-5000 (stainless)

2.3.3 The following manufacturers of the above equipment will be considered equal subject to requirements of Clause "Material and Equipment":

Adam
Ancon LeHage
E. H. Price

2.4 SPRINKLER PROOF EQUIPMENT

2.4.1 This building will be fully sprinklered. Use sprinkler proof electrical equipment to prevent the sprinkler system water from entering electrical equipment for all surface mounted equipment.

2.5 IDENTIFICATION NAME LABELS

2.5.1 Provide white lamacoid identification labels with black uppercase lettering, minimum 14 pt Arial or Helvetica typeface, for identification of all MCCs, switchboards, distribution panels, panelboards, transformers and transfer switches.

2.5.2 Submit a complete list of nameplate wording for review by Consultant prior to installation.

2.5.3 Warning plates are to be red with white letters, minimum 14 pt Arial or Helvetica typeface, as indicated on drawings.

2.6 FLASHING

2.6.1 For locations with roof penetrations serving a piece of equipment, such as for roof mounted split system condensing units, receptacles, etc, use Portals Plus, Inc. Alumi-Flash system consisting of 330 mm (13") high, one piece spun aluminum base with deck flange and EPDM rubber cap. Use caps suitable for required number and diameter of service penetrations. Flashing is for

Divisions 23, 25, 26, 27 and 28 use only. Coordinate with Mechanical Trades to minimize the number of flashings required.

2.6.2 The following manufacturers of the above equipment will be considered equal subject to requirements of Clause “Material and Equipment”:

Portals Plus

3 Execution

3.1 **GENERAL**

3.1.1 Instruct and supervise other Sections doing related work.

3.1.2 Supply the measurements of equipment to other Sections to allow for necessary openings to be left in the work of other Sections.

3.1.3 Install conduit, which is to be concealed, neatly and close to building structure so that the necessary furring can be kept as small as possible.

3.1.4 Carry out all work in accordance with the latest regulations of the Ontario Electrical Safety Code and all applicable Municipal, Provincial and Federal Codes and Regulations. In no instance, however, is the standard established by the Drawings and Specifications, to be reduced by any of the Codes referred to above.

3.1.5 Install all ceiling components in direct accordance with reflected ceiling plans.

3.1.6 Electrical Drawings show approximate locations for wall-mounted devices. Clarify exact location and mounting height with Consultant prior to roughing-in.

3.1.7 All serviceable equipment installed on the roof (including receptacles) to be installed minimum 3 m (10'-0") from roof edge unless otherwise noted on Drawings.

3.1.8 Pack all roof penetration flashings with mineral wool insulation after service installation is complete, to prevent condensation.

3.2 **STORAGE OF MATERIALS**

3.2.1 Provide proper weatherproof storage for the protection of materials and equipment on site. Blank off openings in all equipment until required for use. Consultant may require materials which are not properly stored to be discarded and removed from the site.

3.3 SUPPORTS AND BASES

3.3.1 Provide structural work required for installation of equipment provided under this Division.

3.3.2 Set all floor-mounted equipment on concrete bases at least 100 mm (4) high. Size concrete equipment bases to suit the equipment actually supplied and in accordance with the Shop Drawings of such equipment. Do not start concrete work until anchor bolts and other embedded parts required for the complete installation, as well as Shop Drawings, are available at the site.

3.3.3 Extend existing concrete bases as required for replacement or new equipment. Match existing height.

3.3.4 For new concrete bases or pads on existing floors, first scrape and remove existing floor finish. Scarify existing floor so that new concrete adheres to it. Dowel new pads to new and existing floors.

3.3.5 Provide all brackets and supports required in steel stud walls. All conduits and equipment must be supported on brackets or supports attached to steel studs. Do not support materials or equipment from wall sheathing.

3.3.6 Provide independent support; brackets and unistrut structures where required to install electrical equipment; disconnect switches, splitters, panels, etc:

- in areas where the equipment is located on walls/columns that are not suitable for direct installation.
- When installation away from structural building elements is called for.
- When it is necessary to elevate the electrical equipment to ensure code compliance or ergonomical operator access.

3.3.7 For all supports of suspended or wall hung electrical equipment, provide structural drawings stamped and signed by a structural engineer holding a P.Eng. designation and registered in the Province of Ontario. This engineer is to submit proof of professional liability insurance. Equipment to be supported from the bottom.

3.3.8 Do not mount starters, VFD's, etc. on building equipment.

3.3.9 Do not suspend luminaires greater than 11.3kg (25 lbs), cable tray, conduit racks, etc from metal roof deck. Provide supports as required to suspend from roof joists.

3.3.10 Provide lintels for double-width and adjacent tubs and multiple conduits running in parallel, where located in block and poured walls.

3.4 CONCRETE INSERTS

3.4.1 General

3.4.1.1 Anchors for the support of conduits and equipment from the underside of suspended structural concrete systems may be by cast-in-place inserts placed prior to the pouring of concrete or by the use of inserts placed in holes drilled after the forms are stripped.

3.4.1.2 The safe load capacity of concrete anchors is affected by a number of variables such as specific anchor type, embedment, spacing between individual anchors, edge distances, direction of loading, concrete strength and "prying action". Refer to the manufacturer's recommendations for each specific insert proposed, including any dynamic or vibratory loads.

3.4.1.3 Be responsible for the proper selection and installation of inserts, including number, type, spacing and accurate placement to provide the necessary safe load capacity and satisfactory long term performance.

3.4.2 Installation of Inserts in Hardened Concrete:

3.4.2.1 Use inserts placed in pre-drilled holes. Do not use powder driven inserts or self-drilling inserts. Before drilling holes, accurately locate all reinforcing bars in the affected areas using an electro-magnetic locator.

3.4.2.2 Do not drill through or otherwise damage reinforcing bars. If reinforcing is encountered, the inserts must be relocated. Ensure that hole diameter, depth of penetration, spacing, etc., are in strict accordance with the insert manufacturer's recommendations for the specific insert type and load condition.

3.4.2.3 Due to the relatively close spacing of reinforcing bars in the bottom of many of the beams and girders, the preferred location of drilled-in-place anchors in beams and girders is into the sides of these members, rather than upwards into the bottom.

3.4.2.4 Inserts to be zinc plated female concrete anchors. Nylon or plastic anchors are not acceptable.

3.4.3 Concrete screws without anchors are not acceptable.

3.5 FIRESTOPPING

3.5.1 Provide a listed firestop system in accordance with the Ontario Building Code to seal around all piping, tubing, ducts, conduits, electrical wires and cables, and other similar mechanical services which penetrate part of a building

assembly required to have a fire resistance rating or a fire separation. Refer to Architectural Drawings and Specifications Section "Firestopping and Smoke Seals" for building assembly and fire separation types and locations.

3.5.2 For all penetrations through fire separations required to have a fire resistance rating, use firestop systems with an F rating not less than the fire resistance rating for the fire separation. This includes the sealing of any sleeves provided for future uses. Provide an FT rating where required by the Ontario Building Code. For all penetrations through a Service Room floor, provide a minimum W rating - Class 1 in addition to the fire resistance rating.

3.5.3 At each fire stopping penetrating location, provide a fire stopping identification label indicating the system number installed, products used, date installed and installer's name. Locate label on penetrating service at the penetration location.

3.5.4 All firestopping must be reviewed by the Consultant on site before any firestopping is concealed. Complete 3 destructive tests to confirm compliance with ULC listing, minimum one floor test and one wall test, third test to be Contractor's choice. Contractor to replace fire stopping system after destructive test has been completed. Submit a copy of the report to the Consultant. Report to include as a minimum, confirmation fire stopping shop drawings were used during review, locations where destructive testing was completed, confirmation all fire stopping locations were reviewed and installed systems meet the manufacturer requirements.

3.6 CUTTING AND PATCHING

3.6.1 Flash holes through walls and roof to make weatherproof.

3.6.2 Do not cut or drill holes through floors, roof or structural members before obtaining permission from the Consultant.

3.6.3 For penetrations through walls not required to have a fire rating, seal all spaces between pipe or pipe and surrounding wall construction with a fire-rated foam sealant. Use 3M Fire Barrier, Metacaulk, or Dow Fire Stop UL Classified fire rated foam sealants. Do this as the work progresses, to avoid leaving inaccessible holes at completion of the job. For penetrations through parts of the building assembly required to have a fire resistance rating or acting as a fire separation, see Clause “Firestopping” in this Section.

3.6.4 Before drilling holes through floors or roof slabs, accurately locate and note sizes for each required hole. Get approval of Consultant before any cutting is started.

3.6.5 Where conduits are required to pass through existing walls, floors, and roof, cut and patch the necessary openings.

3.6.6 Where recessed electrical equipment is removed or replaced with equipment of a smaller size, patch openings to match existing wall material.

3.6.7 Where wiring devices (switches, receptacles, etc) are removed from drywall walls, remove device box and patch opening to match existing wall.

3.6.8 Where wiring devices (switches, receptacles, etc) are removed from poured concrete or block walls, remove device and provide blank coverplate.

3.6.9 Include the cost of all cutting and patching in the Lump Sum Contract Price for the work of Divisions 26, 27 and 28.

3.6.10 Remove and replace ceiling where necessary to complete the work of this Division unless this work is specifically included in another Division.

3.6.11 All cutting and patching to be done by the trade specializing in the materials to be cut.

3.6.12 Replace tiles where existing devices removed or allow for patching gypsum ceilings.

3.7 **PAINTING**

3.7.1 Touch up minor damage to finish on equipment supplied with factory applied baked enamel finish. Completely refinish items suffering damage which, in the opinion of the Consultant, is too extensive to be remedied by touchup.

3.7.2 Paint both sides and edges of plywood backboards for electrical and communications equipment before installing equipment. Use one coat fire retardant primer and two coats fire retardant paint.

3.7.3 Paint disconnect switch or breaker for fire alarm and exit light systems in red enamel. Use one coat of primer and one finish coat.

3.7.4 Where walls and/or ceilings are cut and patched for electrical work including the removal of existing devices, paint walls and ceilings to match existing. For walls and ceilings less than 9.3m2 (100 sq ft), paint entire wall. For walls and ceilings larger than 9.3m^2 (100 sq ft), paint area of patch. Painting to be completed by painting contractor.

3.7.5 Include the cost of all painting in the Lump Sum Contract Price for the work of Divisions 26, 27 and 28.

3.8 ACCESS DOORS

3.8.1 Supply access doors wherever equipment, junction boxes, life safety devices, etc., are concealed behind walls or inaccessible ceilings. All devices installed requiring periodic maintenance to be made accessible. Doors will be installed by the trade specializing in the materials receiving access doors.

3.9 IDENTIFICATION

3.9.1 Colour code control wiring consistently throughout the installation and generally match colour coding of internal wiring of pre-wired components. Match existing colour coding in use on site. Verify with Owner prior to installation.

3.9.2 All branch circuits shall be:

Phase A - red
Phase B - black
Phase C - blue

3.9.3 Identify all disconnects, starters, and other control equipment with lamacoid nameplates indicating the equipment controlled and all panels, transformers, etc identifying equipment name.

3.9.4 Lamacoid labels to be mechanically attached with self-tapping screws or rivets. Lamacoid labels attached using adhesive methods are not acceptable.

3.9.5 Identify the panel and circuit number for each wiring device with self-adhesive label on the coverplate. Use clear tape with black 14 pt Arial or Helvetica typeface. Locate labels for receptacles on front of coverplate and labels for switches on rear of coverplate.

3.9.6 Identify all pull boxes, junction boxes or octagon boxes located in the ceiling cavity with the exact use of the box, including circuits contained within. Felt pen is acceptable.

3.9.7 Where equipment is concealed above accessible ceilings, indicate location using coloured-coded marking devices, approved by Consultant, fastened to the ceiling components.

3.10 LOCKS AND KEYS

3.10.1 Where locked panelboards, control panels, terminal cabinets, etc., are specified, use a separate key pattern for each system with all locks in each system common to one key. Provide seven keys of each pattern to the Owner on a 25 mm (1”) key ring. Submit one set of keys with manuals.

3.11 TESTING

3.11.1 All systems must be thoroughly tested before arrangements are made for the final demonstration in the presence of the Owner's staff. Systems to be tested are:

1. Emergency Lighting
2. Lighting Control Systems
3. Voice / Data Cabling

3.11.2 For the following systems, the manufacturer's Testing Representative must be present for the test period and submit a Certificate of Operation to the Consultant:

1. Fire Alarm
2. Variable Frequency Drives / Soft-start Starters

3.11.3 At the completion of the work, demonstrate operation of all systems to the Owner's representative and the Consultant. Promptly rectify any malfunction found.

3.12 TEMPORARY ELECTRICAL FACILITIES FOR CONSTRUCTION

3.12.1 Temporary electrical power is available at the site. Cooperate with owner for use of this power.

3.12.2 Tie in at one location only, as directed. Distribute temporary power from this location.

3.12.3 Arrange and pay for the cost of inspection of the temporary service.

3.12.4 Notify the monitoring company and Owner each and every time a part of the fire alarm system is shut down and reactivated.

3.12.5 Completely remove all temporary facilities when they are no longer required.

3.12.6 Provide fixed temporary lighting for open areas, stairwells and each enclosed room. In open areas and enclosed rooms use 150W A21 lamps, or equivalent, at spacings not exceeding 7.5m. In staiwells use one 100W A21 lamp, or equivalent, at each landing. Lighting to be on dedicated circuits.

3.12.7 Temporary lighting stipulated in this Section, do not include provisions for higher intensity lighting required for a specific operation (concrete finishing, plastering, etc.). This will be the responsibility of the specific trade requiring the higher intensity.

3.12.8 Provide minimum two 120V 20A GFCI receptacles, on dedicated circuits, per 150 m² construction area.

3.12.9 Temporary power requirements stipulated in this Section, do not include provisions for electric space heating, electric welders, or any other item of equipment which requires either a 3 phase supply or connection to a single phase circuit rated in excess of 20 amperes. Any trade using equipment which falls into above categories is to be responsible for providing additional facilities required for such equipment, including any increased sizing. This Division is responsible to see the connection to the temporary system is safe.

3.12.10 Use non-metallic sheathed cable, Type NMW-10, #12 AWG, manufactured in accordance with CSA Spec. C22.2 No. 38, for all temporary lighting branch circuit wiring.

3.12.11 **Temporary Fire Alarm Devices**

3.12.11.1 Notify the local Fire Department and Owner each and every time a part of the fire alarm system is shut down and reactivated.

3.12.11.2 Provide new temporary hard wired fire alarm detectors, pull stations and notification appliances within the construction area.

3.12.11.2.1 Provide one 135°F rate-of-rise heat detector for every 465 m² (5000 ft²) of floor area.

3.12.11.2.2 Provide smoke detectors in all temporary corridors spaced maximum 10m (30 ft).

3.12.11.2.3 Provide a manual pull station at every exit/entrance to the construction area.

3.12.11.2.4 Provide one surface mounted bell for every 560 m² (6000 ft²) of floor area.

3.12.11.3 Use #14 AWG, AC-90 cable for temporary wiring to devices.

3.12.11.4 Connect devices to dedicated fire alarm zones, grouped on a floor-by-floor basis. Provide zone cards as required to suit existing fire alarm panel.

3.12.11.5 Completely verify temporary fire alarm devices any time temporary devices are added, removed or relocated.

3.12.11.6 Once the permanent fire alarm system is operational completely remove all temporary devices and wiring. Turn devices over to the Owner.

3.13 EQUIPMENT SCHEDULE

3.13.1 Equipment Schedules are as shown on Drawings.

3.13.2 In general, the motor or item numbers shown in the Equipment Schedules coincide with those numbers shown for Mechanical Trades.

3.14 GROUNDING

3.14.1 Ground all components of the Electrical system in accordance with the requirements of Section 10 of the Ontario Electrical Safety Code latest edition and the Inspection Authority.

3.14.2 Provide a separate green ground conductor in all raceways.

3.14.3 Ground secondary neutrals of transformers to building ground conductor.

3.14.4 Where attached to equipment, conduits, cabinets, etc., use suitable approved solderless lugs, compression connectors. No soldered or split bolt type connections are to be used on grounding circuits at any point.

3.14.5 All compression connectors, lugs, etc., used in grounding circuits in any location are to have bolts, nuts, etc., of silicone bronze alloy equal to “Everdur” metal.

3.14.6 Clean all surfaces to which bus or cable are to be bolted, of all paint, rust, etc., and work to a bright, flat surface.

3.14.7 Conduit expansion joints and telescoping sections or metal raceways not thoroughly bonded otherwise, are to be provided with approved bonding jumpers or not less than #8 AWG stranded bare copper.

3.14.8 Provide a separate #14 green ground wire for all isolated ground receptacles.

3.15 START-UP SERVICES

3.15.1 Provide the services of a qualified person to be on call and available to the site within one hour, for 2 weeks after work of this Contract is taken over by the Owner. Assist Owner's staff to become familiar with the system operation.

3.16 MAINTENANCE OF EXISTING SERVICES

3.16.1 Take every precaution to locate and protect existing services so that no interruption occurs. If any existing service is damaged due to the work of this Division, arrange and pay for repair. Bear any costs due to interruption of existing services.

3.16.2 Be responsible for maintaining continuity of existing services, and for programming work so that the Owners can carry out their normal business uninterrupted, with the exception of scheduled shutdowns for connection to or rerouting of existing services, at a time agreed to by the Owners, on weekdays, over weekends or after normal working hours.

3.16.3 Permission from the Owner is required before making any connections to or rerouting of existing services. Give seven days prior notice to the Consultant and Owner.

3.17 PROTECTING AND MAKING GOOD

3.17.1 Be responsible for protection of Owner's property, as well as finished and unfinished work, from damage due to execution of work under this Contract. Repair damage resulting from failure to provide such protection to the satisfaction of the Consultant, at no expense to the Owner.

3.17.2 Attach and fasten fixture and fittings in place in safe, sturdy, secure manner so that they cannot work loose or fall or shift out of position during occupancy of building, as the result of vibrating or other causes in normal use of building.

3.17.3 Coordinate and cooperate with other trades, taking into account existing installations, to assure best arrangement of equipment in available space. For critical locations, prepare interference and installation drawing showing work of various sections as well as existing installations, for approval before commencing work.

3.17.4 All new equipment shall be delivered to site wrapped in plastic and removed only after room is thoroughly cleaned and painted, if applicable. Where existing or new equipment must be operational throughout construction in adjacent spaces, ensure door sweeps are installed and mechanical ventilation systems are fully operational. Provide filters with minimum filtration rate of 10 micron (MERV 5) on all make-up air and supply ducts. Ensure filters are regularly changed to maintain adequate airflow.

3.18 REMOVAL OF EXISTING MATERIAL AND EQUIPMENT

3.18.1 Remove existing material and equipment where shown or specified. Equipment such as Fire Alarm devices, and any other special devices are to be turned over to the Owner. Relocate these items to a designated storage site as directed by Owner. Other material and equipment which is removed becomes the property of the Contractor, and must be immediately removed from the site.

3.19 REBATES AND INCENTIVES

3.19.1 Provide all invoices and proof of purchase documentation to Owner as requested for application by Owner for rebates and incentives. All incentives will be paid to the Owner.

3.20 DEFICIENCY REVIEW

3.20.1 The Electrical Contractor shall confirm in writing that the work is complete and ready for inspection. The Consultant will schedule a site visit to review the work and provide a written deficiency list. Once deficiencies have been corrected, the Electrical Contractor shall confirm in writing to the Consultant that all deficiencies have been corrected. The Consultant will schedule a second site visit to review the correction of noted deficiencies. Should any noted deficiencies be found to be still outstanding, the Electrical Contractor shall correct them and again notify the Consultant in writing. Charges to the Electrical Contractor may result from repeat visits after the second visit.

3.20.2 The Electrical Contractor is required to complete all work above ceilings and allow time for deficiency reviews and correction of noted deficiencies in a timely manner in order to accommodate the current Construction Schedule. This includes time for reinspection as required prior to concealing (drywall enclosures, drywall ceilings and acoustic tile ceilings) of any service. The Electrical Contractor will be responsible for uncovering any concealed services for inspection.

3.21 HOURLY LABOUR RATE

3.21.1 Hourly labour rate shall be the actual rate paid to the worker as posted by the local Union Agreement plus a burden mark-up of 100% to compensate for contributions, assessments, employment insurance, health insurance, pension plans, WSIB, taxes, vacation pay, travel, parking, welfare, union package and membership dues, supervision, material handling, training, rest periods, down time, breaks, personal hygiene, small tools, clean up time, profit, other benefits paid to the worker and all other costs incurred by the Company including meetings, office time. Travel time to and from the site shall be at no charge to the Owner. For the purpose of electrical work, the journeyman electrician union rate will be used for all trades completing any electrical work.

3.22 LIST OF ELECTRICAL SUBCONTRACTORS AND MANUFACTURERS

3.22.1 In the Bid documents, name the Subcontractors and Manufacturers for the items listed below. Use only one name for each item. See Clause “Material and Equipment”. Where the name of a manufacturer is not entered on the Bid Form, the Contractor will be required to use the base specified manufacturer.

3.22.2 **Subcontractors**

Fire Alarm System
Data Wiring

3.22.3 **Manufacturers**

Cable Tray
Disconnect Switches
Emergency Lighting / Exit Signs
Fire Alarm Devices
Lighting Control System
Luminaires (by Type)
Motor Control Equipment
Panelboard Breakers
Structured Wiring
Wiring Devices

END OF SECTION

1 General

1.1 **GENERAL REQUIREMENTS**

1.1.1 Conform to the requirements of Section 26 05 00, “Common Work Results for Electrical”.

1.2 **DESCRIPTION OF SYSTEM**

1.2.1 Provide all new wiring and raceways. Where possible, conceal all wiring and raceways above ceilings, in walls and partitions. See Section 26 05 00, “Common Work Results for Electrical”.

2 Products

2.1 **MATERIALS**

2.1.1 Use materials specified herein or approved equal as defined in Clause “Material and Equipment”.

2.1.2 All outlet boxes, wiring devices, equipment and accessories must be C.S.A. approved and be designed for the application intended.

2.2 **RACEWAYS**

2.2.1 Use E.M.T. in concealed locations in concrete block walls, drywall partitions and for main and branch circuit wiring above ceiling spaces.

2.2.2 Use minimum 1/2" (16 mm) conduit for power wiring and 3/4" (21 mm) conduit for motor circuits.

2.2.3 Raceways for motors and equipment are to be dedicated home runs back to source and shall not be grouped with adjacent motors and equipment.

2.2.4 Refer to Section 27 05 28 for communication raceways.

2.2.5 Use set screw steel couplings and connectors. Use raintight steel couplings and connectors complete with "O" rings, in sprinklered buildings.

2.2.6 Use red conduit for Fire Alarm wiring concealed above ceilings, in concrete walls and in mechanical and electrical rooms.

2.2.7 For new devices on existing block or poured concrete walls exposed in finished areas, provide metallic single compartment raceway and appropriate bases.

2.2.8 Use conduit expansion coupling for expansion joint crossing.

2.2.9 Use flexible metal conduit for all final connections to motors and other equipment subject to vibration or which has adjustable mountings. Minimum size 1/2" (16 mm).

2.2.10 Use rigid PVC underground and in concrete floors, unless otherwise noted. Provide marking tape for underground installations in accordance with Ontario Electrical Safety Code.

2.2.11 For exterior above grade installations, use rigid aluminum conduits and fittings. All boxes and conduit bodies shall be die-cast, copper-free aluminum with aluminum covers and neoprene gaskets.

2.2.12 Fasten all raceways with approved supports. Use clamps and all mounting hardware of the same material as the conduit or compatible material to prevent galvanic corrosion.

2.3 CONDUCTORS

2.3.1 Aluminum conductors are NOT permitted on this project.

2.3.2 Use minimum copper #12 AWG RW-90XLPE **stranded** for branch circuiting and receptacle wiring.

2.3.3 Use RWU-90XLPE wire in all below grade locations.

2.3.4 Use minimum size of #14 AWG RW-90XLPE for control wiring.

2.3.5 Use Nexan Drive Rx VFD rated cables from Variable Frequency Drives to motors.

2.3.6 Type AC-90 cable may be used for final drops (maximum 2 m [6.5”]) to lighting fixtures and devices in accessible ceiling spaces. **DO NOT USE AS MAIN BRANCH WIRING FROM PANELBOARDS OR FOR BRANCH CIRCUIT WIRING (i.e. RECEPTACLES, ETC.).**

2.3.7 For wiring to heating equipment, recessed lighting fixtures or where body of fluorescent fixture is used as raceway, use conductors with high temperature insulation of type approved by Electrical Safety Authority.

2.3.8 Use all wire and cable insulation rated 600 volts minimum unless specified otherwise.

2.4 OUTLET BOXES

2.4.1 Use only masonry approved boxes in concrete and masonry construction.

2.4.2 Use 100 mm (4”) square or utility type boxes for surface-mounted boxes and 100 mm (4”) octagonal boxes for ceiling outlet boxes. Use multi-gang boxes for grouped devices. Use wrap-around covers for utility boxes. Use cast aluminium FS type boxes where surface mounted in finished areas.

2.4.3 Use flush-mounted boxes complete with adjustable ears, extension rings and plate rings as required. Do not use shallow or narrow boxes.

2.4.4 Provide FS type boxes c/w rain tight fittings where surface mounted in service rooms or for any surface boxes in sprinklered buildings not located above ceilings.

2.5 WIRING DEVICES

2.5.1 Use specification grade wiring devices, types and ratings shown on the Drawings.

2.5.2 Switched receptacles to be black. Use red devices for receptacles\switches fed from emergency circuits.

2.5.3 Confirm colour of wiring devices and plates with Consultant prior to ordering.

2.5.4 Receptacles

2.5.4.1 125 volt 15 amp white U-ground Duplex Receptacle (CSA 5-15R)
Hubbell Catalogue No. HBL-5252-W

2.5.4.2 125 volt 20 amp white U-ground Duplex Receptacle (CSA 5-20R)
Hubbell Catalogue No. HBL-5352-W

2.5.4.3 125 volt 20 amp white U-ground Tamper Resistant Duplex Receptacle (CSA 5-20R) Pass &Seymour Catalogue No. TR63W, or equivalent. Alternative manufacturers to provide equivalent grade or better.

2.5.4.4 250 volt 30 amp white U-ground Locking (CSA L6-30R)
Hubbell Catalogue No. HBL-2620

2.5.5 Switches

2.5.5.1 125 volt 20 amp white single pole switch
Hubbell Catalogue No. HBL-1221-W

2.5.5.2 125 volt 20 amp three way key switch
Hubbell Catalogue No. HBL1223-L

2.5.6 **Cover Plates**

2.5.6.1 In general, use 302 stainless steel face plates for all flush-mounted devices and die-cast face plates for all surface-mounted devices.

2.5.6.2 All receptacles exposed to weather to have die-cast aluminum duplex gasketted spring door in-use covers.

2.5.7 The following manufacturers of the above equipment will be considered as equal subject to requirements of Clause “Material and Equipment”:

Arrow Hart
Hubbell
Leviton
Pass & Seymour

2.6 **DISCONNECT SWITCHES**

2.6.1 Unless specified otherwise, fused or unfused disconnect switches to be conditionally hp rated, heavy duty type with visible break industrial safety switches in general purpose or weatherproof enclosures as required. NEMA 3R enclosures with large exposed factory mounting holes must be plugged with stainless steel washer, nut, bolt and plug.

2.6.2 For 120V mechanical equipment, provide Hubbell Cat. #HBL1372D disconnect switch with aluminum housing and lockable switch.

2.6.3 For equipment above ceilings such as fans and heat pumps single phase and three phase 30A and below: Hubbell Cat # HBL1379D disconnect switch with aluminum housing or equivalent to be approved by Consultant.

2.6.4 For exterior roof mounted equipment single phase and three phase 30A and below: Hubbell Cat # HBL13R series NEMA 3R disconnect switch with aluminum housing. Or equivalent to be approved by Consultant.

2.6.5 The door to be mechanically interlocked with the operating handle to prevent it from being opened when the switch is in the “ON” position. The handle is to be capable of being padlocked in the “OFF” or “ON” position.

2.6.6 Provide auxiliary contact in the disconnects at fans/pumps located out of site from VFD. Contact to be late make/early break (LMEB) NC function. To be tied back to VFDs shutdown terminals.

2.6.7 The following manufacturers of the above equipment will be considered as equal subject to requirements of Clause “Material and Equipment”:

Eaton
Schneider
Siemens

2.7 OVERCURRENT PROTECTIVE DEVICES - FUSES

2.7.1 Provide fuses for all fusible equipment in this Contract.

2.7.2 Fuse interrupting rating is to be 200,000 amps RMS symmetrical unless otherwise noted.

2.7.3 Rated as noted on the Drawings, 600 volts AC, fuses will be CSA certified HRCI J/Class J Time Delay with dimensions and current limiting performance in accordance with CSA Specification C22.2 No. 106-05 or UL Standard 198C for Class J fuses. HRCI/JY fuses are not acceptable.

2.7.4 The following manufacturers of the above equipment will be considered as equal subject to requirements of Clause “Materials and Equipment”:

Cooper Bussmann
General Electric Power Controls
Littlefuse
Mersen

2.8 FLUSH FLOOR BOXES

2.8.1 In floor workstation boxes to be complete with separate 120V and communication sections. Box to be suitable for slab depth, and accept 2” conduit (in and out) for both power and communications compartments.

2.8.2 Boxes to have black die-cast furniture feed cover.

2.8.3 Units to be CSA approved.

2.8.4 Hubbell SystemOne Eternal Series complete 4-gang shallow floor box.

2.8.5 The following manufacturers of the above equipment will be considered as equal subject to requirements of Clause "Material and Equipment":

Hubbell
Wiremold

2.9 **FLUSH FLOOR BOXES (F4A)**

2.9.1 Provide 4 gang non-metallic floor box or through-floor fitting for all slab-on-grade and suspended slab locations where data outlets or other communication outlets are provided.

2.9.2 To be complete with two 20 amp 120 volt (CSA 5-20R) tamper resistant duplex receptacles in 2 gangs, 1 gangs for data, and 1 gangs for communications as noted on the plans.

2.9.3 Boxes to have hinged lid for flush trimless recessing in tile or carpet floor with brushed aluminum finish.

2.9.4 Units to be CSA approved and meet UL scrub water exclusion requirements.

2.9.5 To be Wiremold RFB4-CI-CI-1 with two CIHT-D plates for power, one CILT-4TKO for data, and one CIHT-GFI plates for communications and FPBTAL lid.

2.9.6 The following manufacturers of the above equipment will be considered as equal subject to requirements of Clause "Material and Equipment":

Hubbell
Wiremold

3 Execution

3.1 **GENERAL**

3.1.1 Unless shown otherwise, the minimum size of all raceways and conductors to be in accordance with the Ontario Electrical Safety Code.

3.2 **CONDUIT INSTALLATION**

3.2.1 Conceal all conduits except in equipment rooms, unfinished area, and where specifically noted. Flush mount all devices, starters, etc., in finished areas. Install all exposed conduits parallel to building walls and partitions.

3.2.2 All conduit supports and fastening accessories installed outside are to be stainless steel or aluminum. Galvanized will not be accepted.

3.2.3 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

3.2.4 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.

3.2.5 Run parallel or perpendicular to building lines.

3.2.6 Run conduits in flanged portion of structural steel. Do not pass conduits through structural members except as indicated.

3.2.7 Group conduits wherever possible on suspended surface channels.

3.2.8 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers. Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.

3.2.9 Do not run conduit through unconditioned (heated or cooled) spaces without approval from the consultant.

3.2.10 Horizontal runs of conduit will not be permitted in walls unless noted otherwise.

3.2.11 In any case, horizontal runs must be located above level of door or transom frames in area.

3.2.12 Vertical conduits must be supported at each floor slab and at the top and bottom of each riser.

3.2.13 Conduits must be supported from building structure. Provide independent unistrut under obstructions such as ductwork for support as required. Support unistrut from structural members. Do not secure to underside of metal pan roof deck.

3.2.14 Conduit placement should follow the following priority:

- Below grade
- In walls or partitions
- In ceiling cavity
- Exposed

3.2.15 Maintain continuity of ground through all connection points. Use sealer lubricant on all threaded connections embedded in concrete, buried in ground or exposed outdoors.

3.2.16 Leave all conduit systems finished complete with outlet boxes, coverplates, bushings, caps, nylon fish wire, etc. Provide bushings for all sleeves.

3.3 CONDUCTORS

3.3.1 Join #8 AWG and larger conductors with compression connectors properly sized. On #10 AWG and smaller, relaxed wing-nut type connectors may be used. Ideal Industries 451, 452 or 453.

3.3.2 Size conductors for a maximum of 2% voltage drop from the supplying panel to the furthest outlet in the circuit. In calculating voltage drop, use 80% of overcurrent rating or design load where known, whichever is less.

3.3.3 For all equipment feeders (panels, transformers, and directly connected electrical loads) over 50m of total installed length, provide voltage drop calculations to consultant for review. Submit calculations prior to installation of any cabling, conduit, and raceways.

3.3.4 Draw wiring into raceways only after all other work that may cause injury to the wire is completed. Use only wiring lubricants that do not shorten insulation life. Use continuous lengths for feeders to panels and large equipment. Do not splice without permission from Consultant.

3.4 GROUNDING

3.4.1 Ground all components of the Electrical system in accordance with the requirements of Section 10 of the Electrical Safety Code latest edition and the Inspection Authority.

3.4.2 Provide a separate ground conductor in all raceways.

3.4.3 Ground secondary neutrals of transformers to building ground conductor.

3.4.4 Where attached to equipment, conduits, cabinets, etc., use suitable approved solderless lugs, compression connectors. No soldered or split bolt type connections are to be used on grounding circuits at any point.

3.4.5 All compression connectors, lugs, etc., used in grounding circuits in any location are to have bolts, nuts, etc., of silicone bronze alloy equal to “Everdur” metal.

3.4.6 Clean all surfaces to which bus or cable are to be bolted, of all paint, rust, etc., and work to a bright, flat surface.

3.4.7 Conduit expansion joints and telescoping sections or metal raceways not thoroughly bonded otherwise, are to be provided with approved bonding jumpers or not less than #8 AWG stranded bare copper.

3.4.8 Provide a separate #14 green ground wire for all outlets connected to a GFCI circuit breaker.

3.5 OUTLET BOXES

3.5.1 Support all boxes independently of the conduits running to them. Use flush boxes in areas where concealed conduit is used.

3.5.2 Check the Drawings to ensure that no outlets are roughed-in at inaccessible locations, where built-in furniture, counters, etc., are to be installed. In such locations, install the outlets above and clear of the trim by approximately 100 mm (4") unless shown otherwise on the Drawings.

3.5.3 **DO NOT INSTALL OUTLET BOXES OF ANY SYSTEM BACK TO BACK**. Offset as necessary to prevent sound transmission between areas.

3.6 **WIRING DEVICES**

3.6.1 Install light switches on lock jamb side of the door as finally hung. Check door swing before roughing-in. Install switches with the "ON" position up. Locate switch as close as practical to door jamb but not closer than 1". Coordinate location with built-in and Owner supplied equipment and furnishings.

3.6.2 When two or more devices are grouped together, mount under a common coverplate unless shown otherwise.

3.6.3 Mount light switches at height as indicated on Drawings.

3.6.4 Mount duplex receptacles 25 mm (1") above a countertop backsplash to bottom of device coverplate.

END OF SECTION

1 General

1.1 **GENERAL REQUIREMENTS**

1.1.1 Conform to the requirements of Section 26 05 00, “Common Work Results for Electrical” and Section 26 05 33, “Basic Materials and Methods”.

1.2 **DESCRIPTION OF SYSTEMS**

1.2.1 **Digital Lighting Management:**

1.2.1.1 Provide Digital Management Control devices as shown on plans and specified herein.

1.3 **SUBMITTALS**

1.3.1 Submit a lighting control sequence of operation schedule with shop drawings outlining control sequence for each type of room. Group rooms with identical sequence of operation and indicate room numbers.

1.3.2 Schedule to identify number of lighting zones, zone type (switching or dimming), auto-on operation (to preset lighting level if applicable), auto-off operation, daylight harvesting, work plane height and illumination as specified herein.

2 Products

2.1 **GENERAL**

2.1.1 Use materials specified herein or approved equal.

2.1.2 In general, switches and automatic wall switches to match wiring device colour. Faceplates for low-voltage switches to match wiring device faceplates. Refer to Section 26 05 33.

2.2 **ADDITIONAL SYSTEM COMPONENTS**

2.2.1 Provide auxiliary relays and other items as shown on the drawings:

2.2.2 **Emergency Shunt Relay**

2.2.2.1 Provide emergency shunt relay to provide control for emergency lighting and force on during a power outage.

2.2.2.2 Shunt relay to shunt ON emergency lighting circuit during a power outage and be enclosed in a self-contained NEMA 1 plenum rated enclosure mountable through a panel knockout or remotely on flat surface.

2.2.2.3 Relay to have indicator LED which illuminates whenever relay is activated.

2.2.2.4 Relay to be continuous duty type with expected relay life of 10,000,000 cycles minimum and an operating time of 18 ms.

2.2.2.5 Relay to be UL-924 listed and cUL listed.

2.2.2.6 Wattstopper ELCU-200-347 or equal.

2.3 DIGITAL LIGHTING MANAGEMENT

2.3.1 Provide a 100% digital lighting control system as shown on the drawings to meet space control requirements of AHSRAE/IESNA 90.1-2013. Provide occupancy/vacancy modes of operation. In general, provide two control circuits per lighting zone with one circuit configured in occupancy mode and other in vacancy mode.

2.3.2 Provide automatic shut-off of receptacles as shown on the drawings. Receptacles to be powered whenever spaces are occupied, regardless of overhead lighting.

2.3.3 System to be capable of adjustment, including programming and photosensors and occupancy sensor parameters, using software residing on a PC. Use of a handheld configuration tool may not be substituted for this programming ability. Room controllers to operate independent of programming PC.

2.3.4 All components to be self-configuring, digitally addressable, capable of ladderless configuration and will not have dip switches or potentiometers.

2.3.5 Provide contact closure to BAS for occupancy status.

2.3.6 Digital Room Controllers

2.3.6.1 Provide digitally addressable two relay controllers. Controllers to be self-configuring, automatically binding the room loads to the connected control devices without commissioning or the use of any tools.

2.3.6.2 Housing to be plenum rated and complete with nipple to mount to standard junction box.

2.3.6.3 Room controllers to have two integral on/off zero-crossing relays rated for 20A at 347V and three connections for digital lighting network connection.

2.3.6.4 Dimming room controllers to have three integral on/off zero-crossing relays rated for 20A at 347V with three 0-10V dimming outputs and three connections for digital lighting network connection.

2.3.6.5 Provide receptacle controllers for circuits as shown on the drawings.

2.3.6.6 WattStopper LMRC-102, LMPL-101, LMRC-210 (dimming), or LMRC-212 (dimming).

2.3.7 **Digital Switches**

2.3.7.1 Low voltage momentary pushbutton switches to be in 2 equal-sized button configuration, white and compatible with standard decorator wall plates. Buttons to be field replaceable without removing switch from wall. WattStopper LMSW-102.

2.3.7.2 Low voltage switches shown connected to dimming room controllers to be momentary pushbutton switches with one button configuration and LED bar graph showing relative light level of controlled load, white and compatible with standard decorator wall plates. WattStopper LMDM-101.

2.3.7.3 Buttons to be field replaceable without removing switch from wall.

2.3.7.4 Switches to have two connection ports for digital network through-wiring.

2.3.8 **Digital Occupancy Sensors**

2.3.8.1 Digital occupancy sensors to provide automatic switching for specified load connected to a room controller. Sensors shall be interchangeable without the need for rewiring.

2.3.8.2 Sensors to have two connection ports for digital lighting network.

2.3.8.3 Sensors to use dual technology (passive infrared and ultrasonic or microphonic) for occupancy detection. Sensors must be initially trigged by both detection technologies.

2.3.8.4 Digital occupancy sensors shall provide digital calibration for sensitivity (0-100%), time delay (1-30 minutes) and test mode.

2.3.8.5 Multiple occupancy sensors shall be able to be added to the digital lighting network without additional configuration.

2.3.8.6 Unless otherwise indicated, provide the following models according to the symbol type:

Type	Symbol	Wattstopper Cat. No.	Mounting
1		LMDX-100	wall at ceiling
2		LMDC-100	ceiling

2.3.9 **Digital Photosensors**

2.3.9.1 Digital photosensors to provide automatic switching or dimming daylight harvesting capabilities for specified load connected to a room controller. Photosensors shall be interchangeable without the need for rewiring.

2.3.9.2 Sensors to have one connection port for digital lighting network.

2.3.9.3 Sensors to have a operational range for wavelengths between 400nm and 700nm and less than 5% sensitivity for wavelengths outside of this range. Light level range shall be from 1-10,000 footcandles complete with a deadband between the ON and OFF setpoints that will prevent the lights from cycling after they turn off.

2.3.9.4 Adjustable head and a mounting bracket shall accommodate multiple mounting positions and building materials. The photosensor may be mounted on a ceiling tile, skylight light well or backbox.

2.3.9.5 Open loop digital photosensors to have an internal photodiode to measure light with a 60 degree cutoff to avoid unwanted light from the interior of the room.

2.3.9.6 WattStopper LMLS-500.

2.3.10 **BACnet Network Bridge**

2.3.10.1 Provide hardware BACnet MS/TP-compliant digital communications between each room and the building automation system (BAS). System to allow occupancy sensor status and sensitivity adjustment through BAS.

2.3.10.2 The network bridge shall automatically create standard BACnet objects for selected room device parameters to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM room devices on each local network. Standard BACnet objects shall be provided as follows:

- Read the detection state of the occupancy sensor
- Read/write the On/Off state of loads
- Read the button states of switches
- Read total current in amps, and total power in watts through the room controller
- Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
- Read/write daylight sensor fade time and day and night setpoints
- Read the current light level, in footcandles, from interior and exterior photosensors and photocells
- Set daylight sensor operating mode

2.3.10.3 WattStopper LMBC-300.

2.3.11 **Isolated Relay Interface**

2.3.11.1 Provide Wattstopper LMRL-100 isolated relay interface to provide contact closure.

2.3.12 **Handheld Configuration Tool**

2.3.12.1 Provide two handheld configuration tools with two-way communication to allow complete configuration and reconfiguration of devices. Unit to have LED or LCD display and be capable of uploading and downloading all configuration settings.

2.3.13 Other manufacturers must meet all of the above requirements and must submit shop drawings to Consultant for review minimum six working days prior to close for compliance review. Equal manufacturers will be added via addendum.

2.3.14 The following manufacturers will be considered as equal, subject to the requirements of Clause “Material and Equipment”:

Acuity Brands Controls
Leviton
Wattstopper

3 Execution

3.1 ADDITIONAL SYSTEM COMPONENTS

3.1.1 Demonstrate to consultant correct operation of shunt relays.

3.2 DIGITAL LIGHTING MANAGEMENT

3.2.1 Provide CMP rated Category 5e with RJ-45 connectors for all control wiring. Wiring in accessible ceiling space may be free run, supported by conduit for other systems. Do not attach cable to ceiling grid supports. In inaccessible ceilings and all walls, provide conduit and back boxes.

3.2.2 Digital lighting network cabling to be green throughout building. Contractor to ensure cabling colour is unique from other low voltage cabling (data, voice, BAS controls, etc).

3.2.3 Program all rooms for 50% automatic ON operation and 100% automatic OFF operation of all circuits. Programming to be in accordance with ASHRAE 90.1.

3.2.4 Adjust time delay so that controlled area remains lit for 5 minutes after occupant leaves area.

3.2.5 Provide assistance to BAS contractor as required to integrate, at minimum, occupancy status with BAS.

3.2.6 Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative who will verify a fully functioning system. Provide Consultant and Owner ten working days written notice of system startup and adjustment date.

3.2.7 Adjust high trim level for luminaires to obtain the following maximum lighting levels at the work plane. Provide high trim percentage and measured illuminance at work plane for each room in maintenance manual.

Space	Work Plane Height	Illuminance
Classrooms	760 mm	30 fc
Offices	760 mm	35 fc

3.2.8 Provide room-by-room documentation on the commissioning of the system including sensor parameters, time delays, sensitivities, daylighting setpoints, sequence of operation, (e.g. manual ON, Auto OFF. etc.) and load parameters (e.g. blink warning, etc.).

3.2.9 Resubmit updated sequence of operation schedule to include high trim setting for each lighting zone and measured illumination at work plane.

3.2.10 Upon completion of commissioning, the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.

3.2.11 Thirty days from occupancy re-calibrate all sensor time delays and sensitivities to meet the Owner's specific requirements. Provide a detailed report to the Consultant of re-commissioning activity.

3.2.12 Turn handheld configuration tools over to Owner’s representative at end of construction. Provide signed letter from Owner confirming receipt, and include in electrical manuals.

END OF SECTION

1 General

1.1 **GENERAL REQUIREMENTS**

1.1.1 Conform to the requirements of Section 26 05 00, “Common Work Results for Electrical” and Section 26 05 33, “Basic Materials and Methods”.

1.2 **DESCRIPTION OF WORK**

1.2.1 Provide panelboard circuit breakers and updated panel schedules as shown on the Drawings.

1.3 **SPRINKLER SHIELDS**

1.3.1 This building will be fully sprinklered. All surface mounted panels and enclosures will include sprinkler shields. Ensure all conduit and fittings in sprinklered areas meet the requirements outlined in 26 05 00 clause "Sprinkler Proof Equipment".

2 Products

2.1 **MATERIALS**

2.1.1 Use materials specified herein or approved equal.

2.1.2 Unless noted otherwise on the Drawings or in Specifications, user operated devices, display and controls shall be located between 125mm (5") and 1830mm (72") from bottom of floor mounted equipment.

2.2 **DISTRIBUTION EQUIPMENT**

2.2.1 **Distribution and Panelboard Circuit Breakers**

2.2.1.1 Unless noted otherwise on Drawings or panel schedules, circuit breakers are to be moulded case as rated below. Series rated breakers are not acceptable unless stated otherwise on the Drawings (ground fault breakers excluded).

2.2.1.2 Breakers are to be suitable for the panelboards provided. All breakers are to be bolted in place. Plug-in only type are not acceptable.

2.2.1.3 For 250V panelboards, main and branch breakers to be rated minimum 22,000 amperes RMS symmetrical at 208 or 240 volt.

2.2.1.4 For 600V panelboards, main and branch breakers to be rated minimum 22,000 amperes RMS symmetrical at 600 volt.

2.2.1.5 All circuit breakers smaller than 400A to be moulded case thermal-magnetic type providing inverse time-current tripping curves. Multi-pole breakers to have common-trip device with single handle.

2.2.1.6 Provide ground fault circuit interrupters breakers as indicated on Panel Schedules. Provide separate neutral conductors for each circuit. Unless noted otherwise, ground fault circuit interrupter breakers are Class A, Group 5mA.

2.2.1.7 Provide positive locking devices on the handles of breakers serving loads below. Trip units to remain free to function while locked in the ON position.

- exit signs
- emergency lighting and night light circuits
- CCTV and network equipment
- door hardware
- smoke fire dampers

2.2.1.8 Provide quantity of spare breakers as called for on the Panel Schedules or Drawings

2.2.2 The following manufacturers of the above equipment will be considered as equal subject to requirements of Clause “Material and Equipment”:

Eaton
Schneider
Siemens

3 Execution

3.1 **PANELBOARDS**

3.1.1 Provide new typewritten directories for all existing panelboards affected by work.

3.1.2 Contractor to provide updated schedules complete with room numbers. Trace out existing circuits as required.

3.1.3 Include room number and description of load for each breaker. For circuits serving mechanical equipment, indicate room number mechanical equipment serves. Coordinate on site with Mechanical Divisions.

3.2 ARC FLASH HAZARD WARNING LABELS

3.2.1 Provide generic shock and arc flash warning labels on all new panelboards, MCC's and disconnect switches and splitters in accordance with Ontario Electrical Safety Code 2-306.

3.2.2 Label shall be located so that it is clearly visible to persons before examination, adjustment, servicing, or maintenance of equipment. Locate label on the inside door of panelboards.

END OF SECTION

1 General

1.1 **GENERAL REQUIREMENTS**

1.1.1 Conform to the requirements of Section 26 05 00, “Common Work Results for Electrical”, Section 26 05 33, “Basic Materials and Methods” and Section 26 29 00, “Motors, Starters and Wiring.”

1.2 **DESCRIPTION OF SYSTEM**

1.2.1 **Motor Control Centres**: Provide modifications to existing buckets as indicated on drawings. Provide all necessary accessories, blank plates/covers, hardware and accessories as required.

2 Products

2.1 **MOTOR CONTROL CENTRES**

2.1.1 Provision is to be made to padlock all starters and breakers in the “open” position.

2.1.2 The motor control centre is to be thoroughly degreased and treated with rust inhibitor after fabricator and shop finished rustproofing primer coat and two coats of CEMA ASA #61 grey baked enamel paint inside and out.

2.1.3 Motor control centre is to be complete with plastic nameplates with engraved letters identifying all equipment.

2.1.4 **MCC Buckets:**

2.1.4.1 Each bucket is to be plug-in design with terminals for all external wires and have:

2.1.4.2 Breakers sized as per Drawings. Minimum 18 kA.

2.1.4.3 Size overcurrent protection as per Mechanical Equipment Schedule. Minimum overcurrent protection to be 15A. All overcurrent protection to be breakers unless otherwise noted.

2.1.4.4 Provide wire identification using slip on PVC wire markers.

2.1.5 Units enclosed in motor control centers shall be of the same manufacturer as that of the circuit breaker and motor control center for coordination and design issues.

2.1.5.1 The following manufacturers of the above equipment will be considered as equal subject to requirements of Clause “Material and Equipment”:

Square D

3 Execution

3.1 **MOTOR CONTROL CENTRES**

3.1.1 Provide all overloads and breakers, properly sized for nameplate current of motors.

3.1.2 Provide power wiring to all motors including all final connection to motor and starters.

END OF SECTION

1 General

1.1 **GENERAL REQUIREMENTS**

1.1.1 Conform to the requirements of Section 26 05 00, “Common Work Results for Electrical”.

1.2 **RELATED WORK**

1.2.1 **Power supply wiring and raceways for motors of mechanically driven equipment:** Supply and installation of wiring and disconnect at motor by Division 26, unless otherwise noted on Drawings.

1.2.1.1 Wiring and raceways for control devices and instruments, such as automatic temperature and pressure control systems, electrical interlocks between starters, field devices and control panels, heat sensors, water temperature controls, thermostatic controls, “ON-OFF” multi-speed controller for cabinet unit heaters: Supply and installation by Divisions 21 through 23.

1.2.1.2 Control wiring and conduit for unit heaters and forced flow units for their associated thermostats and control by Division 25.

1.3 **REFERENCES**

CSA C22.2 No. 14-05 -	Industrial Control Equipment
CSA C22.2 No. 100-04-	Motors and Generators
CSA C390-10 - Induction	Energy Efficiency Test Methods for 3-Phase Motors

1.4 **SYSTEM DESCRIPTION**

1.4.1 **Design Requirements**

1.4.1.1 Divisions supplying motor-driven equipment are to supply and install factory-wired package assembly, field instruments and control devices, including relevant raceway and wiring forming an integral part of automated control system of equipment.

1.4.1.2 Division 26 is to supply and install “power train” such as power supply equipment (switchgears, distribution boards, distribution panels, panelboards), disconnect switches, circuit breakers and splitter boxes, complete with wiring and raceways to termination point at motor or designated power terminals of assembled equipment (packaged unit).

1.4.1.3 Division 26 is to install separately mounted starters and other specified motor control devices handed over by other Division, necessary to complete “power train”.

1.4.1.4 Division 26 is to incorporate into motor control centre all starters, controls, terminals, equipment and wiring as specified herein and/or as indicated on Drawings.

1.5 **SUBMITTALS**

1.5.1 Submit Shop Drawings as defined in General Conditions of the Contract, to include but not limit following:

1.5.1.1 **Starters and Controllers**: Mounting method and dimensions, starter size and type, layout of identified internal and front panel components, enclosure types, wiring diagram for each type of starter and interconnection diagrams.

2 Products

2.1 **FULL VOLTAGE MOTOR STARTERS**

2.1.1 **Manual Starters**

2.1.1.1 Manual single-phase starters to have a double-break silver alloy contact mechanism and pilot light. The overload shall have a field adjustment allowing up to +/- 24% variance in ratings of the nominal heater value.

2.1.1.2 Manual three-phase starters to have a double-break silver alloy contact mechanism and pilot light. The overload shall be ambient compensated bimetallic-type with interchangeable heaters and automatic reset.

2.1.1.3 In service spaces, starters are to be enclosed in a general purpose NEMA 1 enclosure. In finished areas, starters are to be flush-mounted with a stainless steel faceplate.

2.1.1.4 The operating toggle or button shall clearly indicate whether the until is ON, OFF or TRIPPED.

2.2 **PILOT DEVICES, RELAYS AND CONTACTORS**

2.2.1 Selector switches are to be standard duty, oil tight type. When separately mounted, they are to be located in their own enclosures.

2.2.2 Unless noted otherwise, pilot lights to be oil tight, long-life LED type, with transformer.

2.2.3 Install double voltage relays and/or CSA approved segregated auxiliary contacts as required to perform interlocking or other functions. Contacts to suit application.

2.2.4 Relays, other than double voltage, to be electrically operated and electrically held and to have coils of the voltage and the number of contacts to suit the details of the control scheme. Relays to be Square D Class 8502 or equal.

3 Execution

3.1 **INSTALLATION**

3.1.1 **Motor**

3.1.1.1 Installation by Division supplying motor-driven equipment is to comply with governing regulatory authority requirements, applicable Sections of Division 26, and with motor manufacturer's recommended methods.

3.1.1.2 Terminate power supply cables to motor terminal box using flexible conduit connection.

3.1.1.3 Check for correct direction of rotation, with motor not coupled from driven equipment. Cooperate with other Sections supplying motor-driven equipment, to ensure initial start of each motor is correct.

3.1.2 **Starters**

3.1.2.1 Install starters and connect wiring as indicated on Drawings, in accordance with Code requirements, and in accordance with approved wiring diagrams and manufacturer's Drawings.

3.1.2.2 Where multiple devices are located in close proximity, provide 19 mm (3/4) thick plywood panel sized to accommodate group-mounted disconnect switches, starters, splitter box and other required control devices.

3.1.2.3 Provide raceways, boxes, cables and wirings from panelboards or switchgear through splitters, starters and field disconnect switches to complete power supply required for motors.

3.1.2.4 Provide raceways and wirings for control devices and instruments for installation by Division 26 when specified herein. Other control wiring and conduits for field instruments and devices forming part of automated control system for equipment are to be supplied and installed by Divisions installing such system and equipment.

3.1.2.5 Provide raceways and wiring, and terminate in designated power supply connection points of pre-wired equipment or package unit supplied by other

Divisions. All other outgoing control wiring and conduits are to be installed by Divisions supplying and installing pre-wired equipment or package unit.

3.1.3 Check in field and coordinate motor nameplate full load amperes and service factor to ensure correct fuses and overload relay heater elements are installed. Set adjustable relays.

3.1.4 Provide lamacoid nameplates on front cover of starters, separately-mounted control stations, and field-mounted disconnect switches, indicating function or equipment service identification as indicated on Drawings.

3.2 **TESTS AND INSPECTION**

3.2.1 Operate switches and contactors to verify correct functioning.

3.2.2 Operate selector switch or pushbuttons for performance of starting and stopping sequences of contactors and relays. Confirm delays and Fire Alarm override function as specified.

3.2.3 Inspect and test starter operation as per starter manufacturer's instructions.

3.2.4 Full responsibility for proper performance of motors is to be assumed by Division installing such motors.

END OF SECTION

1 General

1.1 **GENERAL REQUIREMENTS**

1.1.1 Conform to the requirements of Section 26 05 00, “Common Work Results for Electrical General Provisions” and Section 26 05 33, “Basic Materials and Methods”.

1.2 **DESCRIPTION OF SYSTEM**

1.2.1 Provide and install new variable frequency drives in separately mounted enclosures as shown on the Drawings.

1.2.2 Variable Frequency Drives (VFD) shall be suitable for use on variable torque pump and fan applications to control the speed of standard NEMA Design B induction motors.

1.2.3 The VFD is to be highly reliable and designed to provide at least 250,000 hours mean time before failure (MTBF) when the specified preventative maintenance is performed.

1.2.4 **Extended Warranty**

1.2.4.1 Each variable frequency drive is to be covered by a one year extended warranty by the manufacturer direct to the Owner. The extended warranty terms and conditions are to be identical to the one year Contract warranty, and the extended warranty period is to commence the day the Contract warranty expires.

1.2.4.2 Include a copy of the extended VFD warranty in each Operation and Maintenance Manual, and, prior to completion of the work, submit a copy of the warranty to the Owner.

2 Products

2.1 **VARIABLE FREQUENCY DRIVES**

2.1.1 The VFD to be a pulse width modulated (PWM) AC to AC converter utilizing the latest isolated gate bipolar transistor (IGBT) technology.

2.1.2 All VFDs regardless of hp rating are to have the same keypads, and be interchangeable regardless of hp rating.

2.1.3 **Disconnect Switch**: Supply an Input Fused Disconnect Switch.

2.1.4 **Bypass**

2.1.4.1 Supply a fully operational horsepower rated manual Bypass system for full speed operation without the VFD.

2.1.4.2 Provide VFD and Bypass output contactors, mechanically and electrically interlocked to allow only one mode of operation at one time. Provide contactor on drive input to isolate drive from supply while in bypass mode.

2.1.4.3 Bypass to be equipped with a door-mounted VFD/OFF/BYPASS and HAND/AUTO selector switches. Provide VFD ON and BYPASS ON indicator lights.

2.1.4.4 In BYPASS position, an integral full voltage non-reversing magnetic starter is to allow for operation in HAND/AUTO modes. In AUTO mode, motor to be controlled by external source.

2.1.4.5 In all modes of operation, external safety interlocks shall immediately stop motor.

2.1.5 **Output Filter**: Supply an output dv/dt filter for 600V motors to protect motor insulation. To be equal to TCI V1K Motor Protection Filter.

2.2 **VFD RATINGS**

2.2.1 Each VFD is to be rated to operate from single phase 120V, 3 phase power at 208V ±10% or 600V ±10% as indicated on the Drawings. The VFD is to be of a robust construction utilizing premium rated power devices and shall operate continuously without failure when connected to utilization voltage. The VFD is to employ a full wave rectifier to prevent input line notching and operate at a fundamental input power factor of 0.95 at all speeds and loads. The VFD efficiency is to be 97% or better at full speed and load.

2.2.2 For drives serving 7.5hp and larger motors, an internally or externally mounted 3% input line reactor is to be provided to reduce input current harmonic content and provide isolation from power line transients such as power factor correction capacitor switching transients and to reduce RFI emissions. DC link choke only is not acceptable.

2.2.3 For drives serving 5hp and smaller motors, DC link choke may be provided to reduce input current harmonic content.

2.2.4 Output voltage and current ratings to match the adjustable frequency operating requirements of standard 3 ph, 60 Hz, NEMA design B motors. The overload current capacity for variable torque overload capacity is to be 110% of rated

current for one minute out of 10 minutes and 150% for two seconds out of 15 seconds with an instantaneous overcurrent trip at 350% or higher. Output frequency to be adjustable between 0 and 60 Hz.

2.2.5 The VFD is to provide full torque at any frequency from 10 Hz to base speed.

2.2.6 VFDs that resort to higher switching frequencies to reduce motor noise are to be sized to provide 100% motor output power at the highest available output switching frequency.

2.2.7 VFDs with switching frequencies that produce singing and whining motor noises are not acceptable.

2.2.8 The VFD is to be furnished in a NEMA 1 enclosure with sprinkler shield rated for operation at ambient temperatures between 0 and 40 C to suit site conditions. The VFD is to be protected from vibration per IEC 68-2-6.

2.3 **FEATURES**

2.3.1 The drive is to be designed to operate on an AC line which may contain line notching and up to 10% harmonic distortion.

2.3.2 The drive is to be designed to shut down with no component failure in the event of an output phase to phase to ground short circuit and provide annunciation of the fault condition.

2.3.3 The drive is to be capable of determining the speed and direction of a spinning motor and adjusting its output to “pick-up” the motor at the rotating speed. The flying start feature is to be operable with, or without, encoder feedback.

2.3.4 The drive is to be capable of control logic ride through in the event of power outages up to two seconds in duration.

2.3.5 In the event of loss of the 4 mA to 20 mA reference signal, the drive is to be User programmable to the following:

- Fault and stop.
- Alarm and maintain last reference (within 10%).
- Alarm and go to preset speed.
- Alarm and go to minimum speed.
- Alarm and go to maximum speed.

2.4 CONTROL FUNCTIONS AND ADJUSTMENTS

2.4.1 Startup data entries to include motor nameplate power, speed, voltage, frequency and current.

2.4.2 Provide a selection of two preprogrammed application macro parameter sets, PFC and HAND/AUTO, with preprogrammed parameters to minimize setup time during commissioning. Additionally two User macros are to be available, User 1 and User 2, for saving custom application parameters. The Pump and Fan Control (PFC) macro, when selected, is to control one pump or fan with the VFD and automatically turn ON or OFF, as demanded by the process.

2.4.3 START/STOP control functions are to include 2 or 3 wire START/STOP, COAST/RAMP STOP selections, optional dynamic braking. An automatic reset function is to execute up to five attempts to restart after individually selected overcurrent, overvoltage, undervoltage and signal loss fault conditions. The automatic reset trial and delay times are to be individually adjustable.

2.4.4 Accel/Decel control functions is to include two sets of ramp time adjustments with linear and S-curve ramp selections.

2.4.5 Speed control functions to include:

2.4.5.1 Adjustable min/max speed (frequency limits in scalar mode).

2.4.5.2 Selection of up to three preset speed settings for external speed control.

2.4.5.3 Two sets of critical speed lockout adjustments (skip frequencies).

2.4.5.4 A built-in PID controller to control a process variable such as pressure, flow or fluid level.

2.4.5.5 Two analog inputs shall be programmable to form a reference by addition, subtraction, multiplication, minimum selection or maximum selection.

2.4.6 The following safety inputs shall be pre-programmed into all drives serving air handling equipment. Provide jumpers where safety interlocks are not used. Upon opening of any contacts, drive to immediately stop load regardless of building automation control or keypad operations. Drive to automatically restart upon contact closure without manual reset.

2.4.6.1 Fire alarm shutdown: shutdown on fire alarm.

2.5 OPERATOR CONTROL PANEL

2.5.1 Each VFD is to be equipped with a front-mounted plug-in operator control panel consisting of a minimum two lines by 16 character backlit alphanumeric display and a keypad with keys for Run/Stop, Local/Remote, Increase/Decrease, menu navigation and parameter select/save. All parameter names, fault messages, warnings and other information are to be displayed in complete words or standard abbreviations to allow the user to understand what is being displayed without the use of a manual or cross reference table. In the “Local” mode all control is to be from the keypad. In the “Remote” mode all speed and Run/Stop control is to be from either of two remote locations (EXT1/EXT2) as selected by the position of the external HAND/AUTO switch or contact:

2.5.1.1 “HAND” position (EXT1) is to select speed reference from an external speed potentiometer.

2.5.1.2 “AUTO” position (EXT2) is to select speed reference from an external location.

2.5.2 During normal operation, one line of the control panel is to display the speed reference, and run/stop forward/reverse and local/remote status. The remaining line of the display is to be programmable to display the values of other operating parameters. The parameter is to include the following:

- Speed in percent, or Hz
- Output frequency, voltage current and torque
- Input voltage, power and kilowatt hours
- Status of discrete inputs and outputs
- Values of analog input and output signals
- Error signals

2.5.3 Control interface inputs and outputs are to include:

2.5.3.1 Three analog inputs, one 0 - 10 V and two are 4 - 20 mA, all independently programmable with at least 10 input function selections. Analog input signal processing functions shall include scaling adjustments, adjustable filtering and signal inversion. Upon loss of input signal, the drive shall be programmable to stop and display a fault message, run at a preset speed and display a warning message or display a warning message and run according to the last reference received.

2.5.3.2 Three discrete inputs, all independently programmable with at least 10 input function selections. Inputs shall be designed for “dry contact” inputs used with either an internal or external 24 VDC source.

2.5.3.3 Two analog outputs providing 4 to 20 mA signals. Outputs shall be independently programmable to provide signals proportional to at least 12 output function selections including output speed, frequency, voltage, current and power.

2.5.3.4 Three form C relay contact outputs, all independently programmable with at least 15 output function selections. Relay contacts to be rated to switch 5 A at 24 VDC or 120 VAC. Function selections to include indications that the drive is ready, running, reversed and at set speed. General, specific warning and fault indications are to be available. Adjustable supervision limit indications are to be available to indicate programmed values of operating speed, speed reference current.

2.5.3.5 The drive includes BACnet MS/TP, Modbus RTU, and Johnson N2 as standard.

2.6 PROTECTIVE FUNCTIONS

2.6.1 For each programmed warning and fault protection function, the keypad is to display a message in compete words or standard abbreviations. The five most recent fault messages and times is to be stored in the drive's fault history.

2.6.2 The VFD is to include MOVs for phase to phase and phase to ground line voltage transient protection.

2.6.3 Output short circuit and ground fault protection rated for 22,000 amps are to be provided per UL508C without relying on line fuses. Motor phase loss protection is to be provided.

2.6.4 The VFD is to provide electronic motor overload protection qualified per UL508C.

2.6.5 Protection is to be provided for AC line or DC bus overvoltage at 130% of max rated or undervoltage at 65% of min rated and input phase loss.

2.6.6 A power loss ride though feature will allow the drive to remain fully operational after losing power as long as kinetic energy can be recovered from the rotating mass of the motor and load.

2.6.7 Stall protection is to be programmable to provide a warning or stop the VFD after the motor has operated above a programmable torque level for a programmed time limit.

2.6.8 Underload protection shall be programmable to provide a warning or stop the VFD after the motor has operated below a selected underload curve for a programmed time limit.

2.6.9 Overtemperature protection shall provide a warning if the power module temperature is less than 5 C below the overtemperature trip level.

2.6.10 Input terminal shall be provided for connecting a motor thermister (PTC type) to the drive's protective monitoring circuitry. An input shall also be programmable to monitor an external relay or switch contact.

2.6.11 The drive protection functions to monitor and annunciate the following conditions as a minimum:

- Overcurrent protection.
- Short circuit protection.
- Undervoltage protection.
- Overvoltage protection.
- Overtemperature protection.
- Ground fault protection.

2.6.12 The drive will execute, on initial power-up, a self-diagnostic check. The integral programming to provide first fault indication of drive protection functions. Fault indication to be retained if input power is lost. The following faults to be displayed on the local programming panel:

- Overcurrent.
- Short Circuit/Ground Fault.
- Undervoltage.
- Overvoltage.
- Overtemperature.
- Power Supply Fault.
- Motor stalled.
- Fault codes to provide direction as to board level and input/output level to aid in troubleshooting.

2.6.13 Provide Human Interface Module (HIM) complete with start, stop, speed adjuster and display.

2.6.14 The following manufacturers and service/startup and commissioning companies of the above equipment will be considered as equal subject to requirements of Clause “Material and Equipment”:

ABB
Allen-Bradley
DanFoss

3 Execution

3.1 **INSTALLATION**

3.1.1 The VFD manufacturer is to provide adequate drawings and instruction material to facilitate installation of the VFD. Contractor to follow manufacturer's installation instructions.

3.1.1.1 Provide one set preprogrammed contacts for Fire Alarm shutdown, as noted on Mechanical Equipment Schedule. Fire Alarm shutdown operation to override all local and remote control. Program display to read “Under Control of Fire Alarm”.

3.1.2 All feeders between VFDs and motors are to be rated 1000V. See Section 26 05 33.

3.2 **STARTUP**

3.2.1 Certified factory startup is to be provided for each drive by a factory authorized service centre. A certified startup form it to be filled out for each VFD with a copy provided to the Owner, a copy kept on file at the manufacturers and copies inserted in Maintenance and Operating Manuals.

3.3 **OWNER'S STAFF TRAINING**

3.3.1 Include in Base Bid for manufacturer's factory trained representative to spend four hours on site for training Owner's staff on the operation, maintenance and startup of the units. Notify Consultant seven days in advance of scheduled training.

END OF SECTION

1 General

1.1 **GENERAL REQUIREMENTS**

1.1.1 Conform to the requirements of Section 26 05 00, “Common Work Results for Electrical” and Section 26 05 33, “Basic Materials and Methods”.

1.2 **DESCRIPTION OF SYSTEMS**

1.2.1 Lighting Systems

1.2.1.1 Nominal 347volt A.C.

1.2.1.2 Branch circuit wiring from 347/600 volt, 3 phase, 4 wire panelboards.

2 Products

2.1 **GENERAL**

2.1.1 Use materials specified herein or approved equal.

2.1.2 Use the product of only one manufacturer for each type of luminaire.

2.1.3 Refer to Luminaire Schedule on Drawings.

2.2 **LED LUMINAIRES**

2.2.1 All LED luminaires must bear an approved certification mark as per Ontario Electrical Safety Code Bulletin 2-7-29. A UL certification mark without the ‘c' is not an approved certification mark.

2.2.2 **Luminaires designed for LED lamps with integral driver** as specified below shall adhere to LED lamp manufacturer guidelines, certification programs, and test procedures for thermal management to guarantee the minimum lamp life and lumen maintenance as specified below.

2.2.3 **Luminaires designed with integrated custom LED’s.** shall be as specified on drawings or approved equal meeting the following requirements:

2.2.3.1 Only products from manufacturers that have been in the lighting manufacturing business for minimum of 10 years will be considered.

2.2.3.2 Modularity, shall be designed to allow for replacement of; driver, LED’s, without specialised tools and without removing luminaire from the ceiling.

2.2.3.3 Performance - LED luminaire with custom lamps must exceed LED lamp parameters specified below for efficacy and lumen maintenance by minimum 15%.

2.2.3.4 Lumen Maintenance - at least 70% of initial lumens for at least 60,000 hours.

2.2.3.5 Minimum luminous efficacy 50 lumens per watt (lm/W)

2.2.3.6 0-10V dimming standard to 10% unless noted otherwise in luminaire schedule

2.2.3.7 Warranty - Written warranty covering repair or replacement for a minimum of five (5) years from the date of purchase. Warranty must be included with maintenance manuals and have a toll-free (e.g., "800") number, or mailing address, or web site address for consumer complaint resolution and future LED replacement upgrade.

2.3 EXIT SIGNS

2.3.1 Signs to be suitable for wall and/or ceiling mounting and be provided with diffusers on the underside for down lighting and directional arrows in the face as indicated on the Drawings.

2.3.2 Signs to be green pictograms, Meeting CSA22.2 No. 141-10 with directonal pictograms and faces as shown on the drawings.

2.3.3 Provide an LED (light emitting diode) type light source, maximum 3 watts, 120/347 volt power supply.

2.3.4 Signs to meet CSA-C860-01 “Performance of Internally Lighted Exit Signs”.

2.3.5 Provide suitable clear acrylic guards as indicated on the Drawings.

2.3.6 Signs to be self-powered for 2 hours constructed from extruded, one-piece aluminum painted white, suitable for wall and/or ceiling mounting. To be Lumacell LA-3-W-S.

2.3.7 The following manufacturers will be considered as equal subject to the requirements of Clause “Material and Equipment”:

AimLite
Beghelli
Emergi-lite
Hubbell
Lithonia
Lumacell
Stanpro

2.4 **LUMINAIRE NOISE**

2.4.1 All ballasted luminaires are to be manufactured to reduce noise below room ambient noise level.

2.4.2 Any luminaire or group of luminaires which can be heard above ambient noise are to be quietened or replaced at no additional cost to the Contract.

2.5 **SPARE LUMINAIRES**

2.5.1 Provide a quantity of 1% spare luminaries (minimum 1) of type G1 and G2 used on project and turn over to Owner at Substantial Completion.

3 Execution

3.1 **INDOOR LIGHTING**

3.1.1 Install luminaires complete with the necessary accessories, conduit supports, ball aligners, hangers, mounting yokes, etc.

3.1.2 Check the type of ceilings before placing an order for luminaires.

3.1.3 Provide independent supports from slabs or steel above hung ceilings. Luminaires are not to be supported solely by the hung ceiling. Nylon inserts are not on approved fastening method for poured concrete. Do not secure to underside of metal pan roof deck.

3.1.4 Obtain revised locations from the Consultant when pipes or ductwork interfere with the proper mounting location of recessed luminaires before roughing-in conduit.

3.1.5 Take all necessary precautions to ensure that all luminaires, diffusers and lamps are left clean at the completion of the job.

3.1.6 Ensure that all luminaires including ballasts and lamps are in good working order at the completion of the job. Replace at no extra cost any defective or burned-out lamps.

3.2 **LUMINAIRES IN SUSPENDED CEILINGS**

3.2.1 Provide adequate additional chain hanger supports for all luminaires in suspended ceiling systems to approval of the Consultant, and in accordance with Ontario Electrical Safety Code Bulletin No. 30-4-12.2016.

3.2.2 All existing luminaires to be removed and reinstalled are to have new chain hangers provided.

3.2.3 Coordinate with the Architect and Ceiling Contractor to determine which ceilings have been designed and constructed to carry the weight of the luminaires, so the support chains can be eliminated.

3.2.4 Ensure all luminaires are mechanically secured to the ceiling system with manufacturer approved clips.

3.3 **LUMINAIRE SCHEDULE**

3.3.1 Refer to Drawings for luminaire type and description.

3.4 **EMERGENCY LIGHTING**

3.4.1 Test emergency for 1/2 hour and verify that the entire system is working properly. Contractor is to complete the Emergency Lighting Test Form and providing a line item for each and every device. A sample copy of the form is attached in Appendix `A'. Submit a letter and the completed form indicating each device has been tested, prior to occupancy. Letter to state the following: "The emergency lighting system has been tested for 1/2 hour and is working in accordance with the Drawings and Specifications".

3.5 **REPLACEMENT LUMINAIRES**

3.5.1 Prior to ordering new luminaires to replace existing, Contractor to verify voltage of existing luminaires.

3.6 **EXIT SIGNS**

3.6.1 Locate exit signs as required to prevent obstruction from view. Mount on walls where possible.

3.6.2 Mount exit signs as required to prevent plumbing, structural supports, etc from obstructing view of exit sign. Provide pendant mounts as required for ceiling mounted signs.

END OF SECTION

1 General

1.1 **GENERAL REQUIREMENTS**

1.1.1 The requirements of the Instructions to Bidders, the Contract Forms, the General Conditions as amended, and the Supplementary General Conditions as hereinbefore written will form a part of the following Specifications and the Contractor will consult them in detail for instructions governing the work.

1.1.2 Conform to the requirements of Section 26 05 00, “Common Work Results for Electrical”.

1.2 **REFERENCES**

ANSI/EIA/TIA-569B - Commercial Building Standard for Telecommunications Pathways and Spaces

1.3 **DESCRIPTION OF SYSTEMS**

1.3.1 **Data Communication System**: Provide a system of empty conduits and boxes, outlets and wiring, as indicated on Drawings. All conduits are to be complete with nylon fishwire. Refer to Section 27 10 00 for cabling details.

1.3.2 **Security System**: Provide a system of empty conduits and boxes, outlets and wiring, as indicated on Drawings. All conduits are to be complete with nylon fishwire. Refer to Section 28 10 00 for cabling details.

1.3.3 **Audio and Video Systems**: Provide a system of empty conduits and boxes, outlets and wiring, as indicated on Drawings. All conduits are to be complete with nylon fishwire. Refer to Sections 27 15 01 and 27 41 00 for cabling details.

1.3.4 **Door Hardware Elevations**: Provide a system of empty conduits and boxes, outlets and wiring, as indicated on the Door Hardware Elevations attached at the end of this section. All conduits are to be complete with nylon fishwire.

2 Products

2.1 **MATERIALS**

2.1.1 Use materials specified herein or approved equal.

2.2 **WIRE BASKET CABLE TRAY**

2.2.1 The tray is to be constructed of high strength electro plated zinc galvanized steel rods.

2.2.2 Cable tray is to be constructed of wire configured in a 51 mm x 102 mm (2" x 4") grid pattern wires welded at the intersection points. The ends of the wire mesh pattern shall be bent up to form the sides of the wire basket tray. The tray will have dimensions 100mm high x 300mm wide (4” x 12").

2.2.3 Straight sections of wire basket tray to be provided in 3 m (10 ft) standard lengths.

2.2.4 A complement of fittings for the cable tray to be available including, but not limited to, sweeping bends and tees, couplings for joining sections of the tray, hangers, a field installed divider and all other components necessary to make the system workable. Additional fittings can be constructed in the field from straight sections and couplings. The fittings and accessories shall be of compatible material.

2.2.5 Where specifically indicated on the drawings, provide powder coated cable tray in all areas exposed to view. Cable tray not exposed to view may be standard finish. Powder coat colour from standard colours (minimum black, grey and white) to be selected at shop drawing stage.

2.2.6 The following manufacturers of the above equipment will be considered as equal subject to requirements of Clause “Materials and Equipment”.

ABB
B Line
Cablofil
Cablepro
Cope
Hubbell
Flextray
Wiremold

2.3 COMMUNICATION/SECURITY/ACCESS CONTROL SYSTEM CONDUIT

2.3.1 Cables shall generally be installed in communication trays or conduit. All new conduit shall be thin wall EMT, sized for the cables required plus an additional 50% for future cables. Minimum conduit size shall be 3/4".

2.3.2 In general, the following table shall be used for communication conduit fill:

Conduit Size	3/4" 21mm	1" 27mm	1-1/4" 35mm	1-1/2" 41mm	2" 53mm	2-1/2" 63mm	3" 78mm
Max UTP	**2**	**3**	**6**	**7**	**14**	**17**	**20**
Max Coax	**2**	**4**	**6**	**9**	**17**	**26**	**38**

2.3.3 Cables shall NOT be attached to pipe or conduit or ductwork, etc.

2.3.4 Conduit ends shall be provided with non-metallic bushings to provide a round edge, which will not abrade the cable jacket.

2.3.5 **Telephone/Data:** Provide single gang device wall boxes, complete with 21 mm (3/4") conduit **up to the cable tray or J hook system**. Provide pull boxes and splice boxes as indicated, for every 30 m (100') of conduit, and more than two 90 bends or equivalent.

2.3.5.1 Stainless Steel faceplates specified in Section 27 10 00 do not fit in all device boxes. Confirm compatibility with Data contractor prior to rough-in.

2.3.6 **Fibre Optic Backbone:** All fibre optic backbone cables to be in conduit system. Conduits to be factory painted orange.

2.3.7 **Security/Access Control System:** Provide single gang device wall boxes, complete with 16 mm (3/4") conduit **up to the cable tray or J hook system**. Provide pull boxes and splice boxes as indicated, for every 30 m (100') of conduit, and more than two 90 bends or equivalent. All conduits to have pull strings from device wall boxes to cable tray.

2.3.8 **Door Hardware Elevations:** Provide single gang device wall boxes, complete with 16 mm (3/4") conduit as indicated on Door Hardware Elevations attached. Provide pull boxes and splice boxes as indicated, for every 30 m (100') of conduit, and more than two 90 bends or equivalent. All conduits to have pull strings.

2.3.9 PVC conduit is not allowed inside and will be removed at the contractor's expense.

3 Execution

3.1 **WIRE BASKET CABLE TRAY**

3.1.1 Wire basket to be installed in accordance with all appropriate NEMA VE-2 2000, Ontario Electrical Safety Code, and NFPA standards

3.1.1.1 Wire basket tray to be supported on 3m (10') centres with centre rod hangers as manufactured by tray manufacturer. Trapeze/centre rod hangers to be hung with 1/4" x 3/8” (6.35 mm or 9.53 mm) threaded rod.

3.1.1.2 All connections to be checked to make sure they are correctly tightened and to ensure that all tray sections and fittings are electrically continuous and bonded with adjacent systems in accordance with the Ontario Electrical Safety Code for proper grounding.

3.1.1.3 All systems to be installed complete. Work to include fastening all trays to adjacent wiring systems to install a complete system as indicated on the electrical and/or communication drawings and in the applicable specifications.

3.2 COMMUNICATION WIRING HANGERS

3.2.1 Refer to floor plans and details and install communication system wiring hangers as indicated.

3.2.2 Coordinate location of all hangers with Division 15 and building structure to ensure no conflicts. Hangers are to be mounted within 400 mm (16”) of a 45 or 90 change in cable routing and on 910 mm (36”) spacing.

3.2.3 Provide minimum three hangers on each support rod or as shown on the Drawings.

3.3 COMMUNICATION/SECURITY/ACCESS CONTROL SYSTEM CONDUIT

3.3.1 Provide 21mm (3/4”) conduit except as noted, from each wall outlet to accessible ceiling space. **Ensure end of conduit is fully accessible for cabling installers.**

3.3.2 Provide all conduits, outlet boxes and wiring for a complete system. Minimum size conduit to be 21 mm (3/4"), except where noted.

3.3.3 Where possible, run all conduit in the ceiling space and conceal all conduit within ceiling spaces, walls or partitions. Mount outlets at the same elevation above finished floor level as duplex receptacles or as noted on the floor plans.

3.3.4 Rigidly install all conduits, adequately supported and properly reamed at both ends. Join sections of conduits by approved couplings and conduit terminations at boxes, pull boxes, etc. using approved fittings.

3.3.5 The inside radius of bends not to be less than: Six times the internal diameter of conduits 50mm (2") and smaller.

3.3.6 Install conduits and boxes as per TIA/EIA-569-A.

3.3.7 Minimum size of pull boxes and splice boxes to be sized as per conduits and Tables 5, 2-2 and 5, 2-3 in TIA/EIA-569-A.

3.3.8 Conduits shall be grounded minimum at one end.

3.3.9 Conduit fill capacity shall not exceed 35%.

3.3.10 Cables and raceway shall maintain minimum 150mm (6”) separation from sources of heat such as steam or hot water pipes, vessels and fittings, which are insulated, and minimum 610mm (24”) from the same, which are uninsulated.

3.3.11 Pull wires must be provided in all conduits.

END OF SECTION

1 General

1.1 **CERTIFIED SYSTEM VENDOR**

1.1.1 Data Communications work as specified will be the responsibility of the Contractor and equipment Vendor to:

1.1.1.1 Provide a minimum 20-year complete system performance warranty.

1.1.1.2 Provide a certified CAT6A compliant wiring system for based on contract documents.

1.1.1.3 Perform the pulling of all voice and data system cables.

1.1.1.4 **ONLY** qualified technicians directly employed by the Contractor and Vendor trained technicians will terminate all cables (at both ends), test and perform cross-connects.

1.1.1.5 After completion, provide testing as per ANSI/EIA/TIA-568A Addendum 5 on all cable runs, and documentation of test results.

1.1.1.6 Provide and install equipment as specified herein.

1.1.1.7 Provide documentation of the installation. Approval from Brock ITS department is required before starting installation.

1.1.1.8 Provide System Vendor Letter of Certification/Warranty upon completion of job, which will include the notification of a CAT 6A compliant performance level, the Certification/Warranty Number, the identification of the installation by the location and installation date.

1.1.2 Approved Certified System Vendors are required to provide a complete voice/data system; including all cables, fibre optic cables, patch cables, outlet jacks, patch panels, fibre patch panels which meet compliance requirements. This includes station data cables with quantities representative to the number of data lines run to the remote locations. They will be a range of lengths (a percentage of 7-feet, 10-feet, and 15-feet).

1.1.3 The Contractor’s technicians are to have extensive training by the Certified System Vendor on the installation, terminations, testing and verification of the Vendors complete CAT6A system.

1.1.4 The following manufacturers are considered as equal, subject to the requirements of Clause “Material and Equipment”:

- Copper data and voice station cabling: CAT 6A Belden.
- Voice backbone and riser cabling: CAT3 Belden.
- Fiber-optic backbone and riser cabling: Belden
- Horizontal Rack Cable Management: Panduit.

1.2 PREAPPROVED CONTRACTORS

1.2.1 Provide and install equipment as specified herein and approved by Brock ITS department.

1.2.2 The successful contractor/vendor awarded to perform the scope of work described herein, must have a minimum of five (5) years experience.

1.2.3 The vendor must have a Registered Communications Distribution Designer (RCDD) or equivalent BICSI industry standard certification.

1.2.4 The vendor must have manufacturer / industry certified installers and technicians on staff assigned to this project. Substitute personnel will not be accepted. Installers and technicians must have a minimum of two (2) years experience.

1.2.4.1 The following vendors are preferred:

Telcon DatVox

Systemmacs Voice Data Solutions

1.3 SUBMITTALS

1.3.1 Shop Drawings

1.3.1.1 Supply Shop Drawings in accordance with Section 26 05 00 Common Work Results for Electrical. Do work in accordance with reviewed Shop Drawings.

1.3.1.2 Submit complete cabling system layout for voice and data, cable routing summary and cable outlet designations. Approval from Brock ITS department is required before starting installation.

1.3.1.3 All cabling to be CMP rated.

1.3.1.4 Submit detailed layout drawings for termination racks. Approval from Brock ITS department is required before starting installation.

1.3.1.5 Manufacturer’s data on all devices, cables, patch panel, etc.

1.3.1.6 Detail exact location of equipment indicating wiring raceways, pull, junction and terminal boxes.

1.3.1.7 Provide cable trays for distribution of data cabling in main corridors and the appropriate-sized conduits branching off into the cable trays at other locations.

2 Products

2.1 **HORIZONTAL DISTRIBUTION SYSTEM**

2.1.1 The Horizontal Distribution System delivers connectivity from the Patch panel in the LAN Room to the work area. Four pair CAT6A UTP CMP rated cables will be used for this purpose.

2.1.2 Horizontal cabling will be terminated within the LAN Room and at the Telecommunications outlet, using the products specified herein. Quantities must be determined by the cable system installer after review of the Drawings.

2.1.2.1 **Horizontal Station Cables:**

2.1.2.1.1 Cable from each station drop to the communications closets.

2.1.2.1.2 CAT6A (350MHz), 4-Pair, F/UTP-foil shielded, Plenum-CMP, Premise Horizontal cable, 23 AWG solid bare copper conductors, FEP/PO insulation, patented X-spline, overall Beldfoil® shield, Flamarrest® jacket. Belden GigaFlex 2400 series (2413F Plenum); blue.

2.1.2.1.3 CAT6A Horizontal cabling is to be provided to wireless access points, CCTV, card readers, outlets,, information displays, TV's, workstations and any other location as indicated on drawings.

2.1.2.2 Cables shall be 4-pair, unshielded, twisted pair (F/UTP), category 6A, CMP/FT6 rated. Smaller diameter F/UTP (foil shielded over unshielded twisted pairs) preferred over UTP for each of installation, reduced bundle size and smaller bend radius.

2.1.2.3 Cables shall be able to support voice and data to at least 10 Gbps and shall have electrical performance specified to 550MHz.

2.2 **RACEWAYS**

2.2.1 Refer to Section 27 05 28 for raceway details.

2.3 **SYSTEM COMPONENTS**

2.3.1.1 **Jacks**: Provide suitable Belden Cat 6A components to form an installed system.

2.3.1.1.1 Jacks to be blue in colour for all data connections. Each 4 pair cable to be

terminated a blue MDVO jack - Belden part number AX101071. Data pin/pair assignment must meet T568A Standard. Parts TBD.

2.3.1.2 All faceplates to be MDVO, white in colour. Stainless steel faceplates shall not be used for any applications.

2.3.1.3 All communications outlets shall be installed within deep, single or multi-gang boxes, sized to support CAT6A cable.

2.3.2 **Voice and Data Cable**: Provide cable solution to meet certification.

2.3.2.1 All horizontal copper cables to be blue.

2.3.3 **Patch Cables**

2.3.3.1 All patch cables supplied must be of the same brand as the terminations and horizontal cable used. Patch Cords used at the telecommunication rack and at the workstation must be prefabricated stranded Cat 6A, 24 AWG, 4 pair assemblies.

2.3.3.2 Provide the following:

2.3.3.2.1 7ft, 10ft and 15ft length patch cables.

2.3.3.2.2 Quantity of cables must equal the number of horizontal drops.

2.3.3.2.3 CAT6A Patch Cable, Bonded-Pair, 4 Pair, 24 AWG Solid, CMR, T568A/B-T568A/B, blue.

2.3.3.2.4 7ft Belden ordering part # C601106007.

2.3.3.2.5 10ft Belden ordering part # C601106010.

2.3.3.2.6 15ft Belden ordering part # C601106015.

2.4 TELECOMMUNICATIONS GROUND BUSBAR

2.4.1 Comply with OESC and TIA/EIA-607 grounding and bonding requirements.

2.4.2 Provide telecommunications ground busbar in each equipment room as shown on the Drawings. Busbar to be predrilled 6mm (1/4") x 20mm (3/4") thick copper with fiberglass-reinforced unsaturated polyester stand-off insulators.

2.4.3 For equipment rooms, provide 10mm x 51mm x 305mm (3/8"x2" x 12") busbar with 9 predrilled holes. Erico EGBA series, pattern CC or equal.

2.4.4 Refer to section 27 05 26 Grounding and Bonding for Communications Systems for additional requirements.

3 Execution

3.1 **INSTALLATION**

3.1.1 The Contractor will supply, install, test, document and certify the cable system according to this specification and must comply with able plant installation and termination procedures as specified in the CSA T529-95 Standard for horizontal and backbone copper and fibre-optic cabling systems as well as the manufacturer's CSV cable installation practices.

3.1.2 The Contractor will correct deficiencies at no cost to the Owner.

3.1.3 Base Wiring includes:

1. Cable
2. Jacks/Patch Panel
3. Distribution and Termination
4. Testing and Labelling
5. Patch Cables

3.2 **IMPLEMENTATION**

3.2.1 **Horizontal Cabling and Termination**

3.2.1.1 Within the LAN Room, horizontal cable terminations and rack installation will be as per Drawing Details and specifications.

3.2.1.2 **The horizontal data cabling** will be terminated on Patch panels, mounted in 19-inch standard racks within the rooms indicated on plans. Provide one dedicated data cable per telecommunications outlet (or as specified on Drawings). Horizontal data cable length to the farthest outlet will not exceed 90 m (295") as specified in CAN/CSA-T529. All Data cabling is to be Category 6 CMP. CMR cable will not be permitted.

3.2.1.3 Provide sufficient vertical and horizontal wire managers on the rack for Patch Cord management.

3.2.1.4 Unused ports on faceplates will be filled with the appropriate blank insert.

3.2.1.5 Each 4 pair cable to be terminated in an eight-position module with Belden part number AX101071. Data pin/pair assignment must meet T568A Standard.

3.2.1.6 All cable runs will be completed without splices.

3.2.2 Support cables using Velcro or wiring harnesses. Utilize cable trays and/or conduits to manage cable in orderly fashion.

3.2.3 Route all cable in such a way as to ensure maximum separations from sources

of EMI as defined in CAN/CSA T529. Do not run cables above light fixtures, motors, speakers, air diffusers or similar locations.

3.2.4 Designate all data and voice outlets as per Drawings and Specifications.

3.2.5 Place all exposed cabling in a neat and professional manner and route as per Specifications and Drawings. Comb and/or route cabling in such manner as to ensure bundled cabling is neat and parallel to other cables in bundle. Velcro all exposed cable bundles at maximum of every 200 mm (8").

3.2.6 Securely mount data and voice outlets at all work area locations using screws as opposed to self-adhesive strips.

3.2.7 Fibre optic cables must be run separately from copper cables.

3.2.8 Do not exceed cable bending radii or rated pulling tensions.

3.2.9 All fiber optics runs must be installed as a continuous run with no splicing permitted between locations with the exception of connector pigtail fusion splice at each end of the run.

3.2.10 All fusion splices must have average loss equal, or less than 0.20 dB measured using 1310 nm optical source. The test will be bi-directional with no splice loss being greater than 0.20 dB. Since the test is bi-directional, the splice loss refers to the final loss value obtained once both test results are averaged at each splice; none being greater than 0.20 dB.

3.3 LABELLING

3.3.1 Labelling must conform to Brock ITS standards.

3.3.1.1 Review proposed labelling with **Brock** ITS team prior to proceeding.

3.3.1.2 Brady type labelling within 6-inchesof each end of the horizontal cable to be used to indicate room number behind the patch panel.

3.3.1.3 Labelling on the front coverplate of the outlet must meet Brock labelling standards.

3.3.1.4 Labelling on the label area of the patch panel using manufacturer supplied labelling material must indicate the room number and number of the drop within that room, if there is more than one.

3.3.1.5 All other labelling is to be done using mechanically printed labels on permanent self-adhesive white labels with minimum 3/16-inch height.

3.4 TESTING

3.4.1 All cables will be tested as per ANSI/EIA/TIA-568B, ANSI/EIA/TIA-568-

C.1/C.2. All test records will be completed by the CSV. All test instrumentation, test records, and labour required for the testing will be supplied by the CSV/Contractor.

3.4.2 All optical fibre cables will be tested as per ANSI/EIA/TIA-568-C.3. All test records will be completed by the CSV. All test instrumentation, test records, and labour required for the testing will be supplied by the CSV/Contractor.

3.4.3 All cable faults will be corrected by the CSV/Contractor at no cost to the Owner. Splicing of cable pairs is not permitted for the repair of any cables. If a cable is found to be defective, it must be replaced.

3.4.4 Provide test result documentation within two weeks of completion of cable installation.

3.4.5 Inform Consultant 10 working days before testing is carried out so that the Consultant can witness all tests. Rectify wiring deficiencies immediately.

3.4.6 Carry out testing only after installation and termination/labelling of communications cabling at; floor tiles, surface-mounted telecommunications outlets, wall or ceiling-mounted telecommunications outlets as per specified drawings, after substantial completion.

3.4.7 All test results will be verified by consultant and Brock ITS staff prior to invoicing.

3.4.8 The completed installation will be inspected by Brock ITS staff prior to invoicing.

3.5 **DOCUMENTATION**

3.5.1 Provide complete documentation of the installation and testing.

3.5.2 Provide Vendor Certification upon completion of cable installation.

3.5.3 Provide records and AutoCAD Drawings complete with all jack locations and numbers (voice and data).

3.5.4 All documentation will be verified by Brock ITS staff prior to invoicing.

END OF SECTION

1 General

1.1 **GENERAL REQUIREMENTS**

1.1.1 Conform to the requirements of Section 26 05 00, “Common Work Results for Electrical”.

1.2 **DESCRIPTION OF SYSTEMS**

1.2.1 **Fire Alarm System**

1.2.1.1 Supply and install all equipment and accessories to extend the existing electrically supervised, coded, zoned fire alarm system by Edwards EST as described herein and as shown on plans. Fire alarm devices are to be in accordance with the Ontario Building Code and associated standards.

1.2.2 **Valve Supervisory System**

1.2.2.1 In conjunction with the fire alarm system, supply and install all equipment and accessories for an electrically supervised valve system.

1.2.2.2 The system is to provide individual supervision of sprinkler and fire standpipe supervised valves and flow switches indicated.

1.3 **SPRINKLER SHIELDS**

1.3.1 This building will be fully sprinklered. All surface mounted panels and enclosures will include sprinkler shields. Ensure all conduit and fittings in sprinklered areas meet the requirements outlined in 26 05 00 clause "Sprinkler Proof Equipment".

1.4 **INTEGRATED SYSTEMS TESTING**

1.4.1 This building requires integrated systems testing as required by the Ontario Building Code. Refer to requirements outlined in this specification and attached appendix. This work needs to be coordinated, scheduled and reports provided to the Consulting team well in advance of the required occupancy date. Schedule this testing accordingly in consultation with the general contractor and IST Coordinator.

2 Products

2.1 **FIRE ALARM CONTROL PANEL**

2.1.1 Existing Fire Alarm Control Panel is Edwards EST.

2.1.2 Consult with fire alarm manufacturer to determine accessories and wiring diagrams required to extend the existing fire alarm system. Extras will not be granted for failure to consult with fire alarm manufacturer.

2.2 ADDRESSABLE DEVICES

2.2.1 Provide suitable wire guards for all devices where indicated on the drawings.

2.2.2 **Manual Pull Stations:** Manual single action break-glass addressable pull stations to be Edwards SIGA-270. Provide flush box for all new installations. Provide auxiliary contacts as required for release of magnetic locks where noted on the drawings.

2.2.2.1 Provide matching red die cast surface mount box in locations where pull stations are surface mounted.

2.2.2.2 Provide STI Series Stopper II UL/ULC pull station cover with integral local alarm where indicated on the drawings. To be Edwards STI-1100.

2.2.3 **Photoelectric Smoke Detectors**: Addressable photoelectric smoke detectors to be Edwards SIGA-OSD. Provide SIGA-SB standard sensor base, SIGA-RB sensor base with addressable supervised relay driver, or SIGA-AB4G audible base as indicated on the drawings.

2.2.4 **Addressable Monitor Module**: For monitoring valves, flow switches, and conventional devices, Edwards SIGA-UM. Monitor modules shall be capable of powering 2-wire smoke detectors.

2.2.5 **Addressable Control Module:** Provide control relays to allow for various addressable control functions, Edwards SIGA-CR. Relays shall be rated for 0.5A at 120VAC. Relay to change to open state upon loss of communication.

2.2.6 **Zone Isolation Modules**: Provide isolator at zone separations, fire separations and where required by the manufacturer. Alternately provide SIGA-IM isolator bases.

2.2.7 **Power Isolation Modules**: Provide 24VDC power isolator at zone separations, fire separations and where required by the manufacturer.

2.3 NON-ADDRESSABLE DEVICES

2.3.1 Provide suitable wire guards for all devices where indicated on the drawings.

2.3.2 **Manual Pull Stations:** Manual single stage, single action break-glass pull stations to be Edwards 270-SPO. Provide flush box for all new installations. Provide auxiliary contacts as required for release of magnetic locks where noted.

2.3.2.1 Provide matching red die cast surface mount box in locations where pull stations are surface mounted.

2.3.2.2 Provide STI Series Stopper II UL/ULC pull station cover with integral local alarm where indicated on the drawings.

2.3.3 **Photoelectric Smoke Detectors**: Photoelectric smoke detectors to be Edwards C2M-PDC with auxiliary alarm relay contacts as indicated on the drawings.

2.3.4 **End-of-line Resistors:** To be sized to ensure correct supervisor current flows in each circuit. Provide faceplates for mounting on single gang plate bearing ULC label. Fire alarm faceplates material and colour are to match wiring device faceplate.

2.4 NOTIFICATION APPLIANCES

2.4.1 Provide suitable wire guards for all devices where indicated on the drawings.

2.5 SPEAKERS AND SPEAKER STROBES

2.5.1 **Speaker (Ceiling Mounted):** Ceiling mounted speakers are to have white round housing, suitable for 25 or 70.7 VRMS operation with 4 field selectable power taps from 1/4W to 2W. Edwards GC-S2 / GC-S7.

2.5.2 **Speaker-Strobe (Wall Mounted):** Wall mounted speakers-strobe are to have red housing with white “FIRE” lettering with field selectable 15, 30, 75 or 110 candela, 1 Hz synchronized xenon high output strobe, suitable for 25 or 70.7 VRMS operation with 4 field selectable power taps from 1/4W to 2W. Edwards G4RF-S2 / G4RF-S7.

2.5.3 **Speaker-Strobe (Ceiling Mounted):** Ceiling mounted speakers-strobes are to have white round housing with red “FIRE” lettering, with field selectable 15, 30, 75 or 110 candela 1Hz synchronized xenon high output strobe, suitable for 25 or 70.7 VRMS operation with 4 field selectable power taps from 1/4W to 2W. Edwards GCF-S2VM / GCF-S7CM.

2.5.4 Provide red adapter skirt for surface mounted devices on walls.

2.5.5 Provide tile bridge for all devices mounted in acoustic ceiling tile ceilings.

2.5.6 Provide wire guard with mounting plate where indicated on the drawings.

2.6 PASSIVE GRAPHIC ANNUNCIATOR

2.6.1 Provide passive graphic mounted adjacent to the main panel and annunciator panels. Graphic is to be minimum 410 mm x 410 mm (16 x 16) graphic outline

of building, minimum five zone identification colour, mounted in a frame behind a acrylic faceplate with tamperproof screws of building identifying each zone.

2.6.2 The graphic is to be designed with each zone a different colour to the adjacent zone for easy identification. All zones are to be displayed and labelled same as annunciator. Location of fire alarm system panels to be shown on passive graphic.

2.6.3 In partially sprinklered buildings, identify areas that are sprinklered utilizing hatching.

2.6.4 Identify locations of supervised valves, flow switches and other fire suppression systems. Passive graphic, annunciator and field device identification tags must be displayed and labelled verbatim.

2.6.5 Floor plans to be shown in 'track up' orientation based upon location of passive graphic.

2.7 **WIRING**

2.7.1 Provide new wiring to conform with requirements of Ontario Electrical Safety Code Section 32, and applicable Codes and Standards. Size wiring in accordance with Class 2 requirements, but protected from mechanical injury or other injurious conditions such as moisture, excessive heat or corrosive action in accordance with Class 1 requirements.

2.7.2 General wiring with a floor area, conductors to be solid copper Securix II, Type 105 C PVC, 300 volt. Minimum size of any conductor: for alarm receiving circuits and remote annunciators, #16 AWG solid. Wire resistance in these circuits not to exceed 50 ohms. For audible signal circuits minimum #16 AWG solid. Voltage drop to any signal not to exceed 10%.

2.7.3 Conductors in multi-conductor cables to have allowable temperature rating of at least 105 C (200°F).

2.7.4 All conductors to be as per Ontario Electrical Safety Code and installed in metallic raceway.

2.7.5 Install conductors entirely independent of all other wiring and do not enter fixture, raceway, box or enclosure occupied by other wiring.

2.7.6 Splices will not be permitted unless otherwise indicated on the Drawings or specified. Where splices are necessary and approved by the Consultant, use approval metal contact electrical crimp type connectors.

2.7.7 All wiring must be clear of shorts, open and grounds on completion of work.

2.8 **MANUFACTURER**

2.8.1 The following manufacturers of the above equipment will be considered as equal subject to requirements of Clause “Materials and Equipment”:

Edwards

2.9 **INTEGRATED SYSTEMS TESTING**

2.9.1 Provide Integrated Systems Testing as indicated in CAN/ULC-S1001-11 "Integrated Systems Testing of Fire Protection And Life Safety Systems. Refer to attached appendix for details regarding scope, various parties involved and the systems to be included.

2.9.2 Contractor to engage with a 3rd party commissioning type contractor to arrange for this work. In general, systems to be tested for proper integration with the fire alarm system are noted in CAN/ULC-S1001-11 and include but are not limited to elevators, cooking equipment fire suppression systems, hold-open devices, electromagnetic locks, smoke control systems, emergency generators, audio/visual and/or lighting controls, notification systems, sprinkler systems, standpipe systems, fire pumps, water supplies, water supply control valves, freeze protection systems, fixed fire suppression systems.

3 Execution

3.1 **FIRE ALARM SYSTEM INSTALLATION**

3.1.1 Fire alarm system installation to be in accordance with the latest edition of CAN/ULC S-524 “Standard for the Installation of Fire Alarm Systems”.

3.1.2 **Wiring**

3.1.2.1 Riser diagrams on drawings show general design intent. Obtain complete wiring diagrams from Fire Alarm manufacturer prior to rough-in.

3.1.2.2 Provide all wiring in conduit and in accordance with Fire Alarm equipment manufacturer's requirements.

3.1.2.3 Identify signal circuit, initiating circuit, auxiliary circuit and all other wiring at Fire Alarm control panel, annunciator, terminal boxes or elsewhere on completion of work with appropriate marking labels.

3.1.2.4 All conventional initiating wiring to be Class B.

3.1.2.5 All initiating and D.C. signal circuits extending from the fire alarm control to be current limited and protected, in accordance with Ontario Electrical Safety Code requirements.

3.1.2.6 The extended circuit wiring to each alarm receiving circuit or signal circuit is to be individually supervised with no common wiring.

3.1.2.7 Install all wiring in EMT metal conduit above ceilings, and surface in mechanical spaces, and in maintenance/storage spaces with exposed ceilings.

3.1.3 Control Panels, Transponders and Annunciators

3.1.3.1 Install the main control panel and annunciators as shown on the Drawings.

3.1.3.2 In finished areas, recess control panel and annunciator in walls. Where not feasible, confirm with consultant prior to rough-in. In this case, provide enclosure without knockouts suitable for surface mounting.

3.1.3.3 Passive graphic, annunciator and field device identification tags provided by Fire Suppression Contractor must be displayed and labelled verbatim.

3.1.3.4 Review zone identification with Fire Inspection Department prior to programming, labelling and manufacturing passive graphics.

3.1.4 **Devices**

3.1.4.1 Install detectors in accordance with CAN/ULC Standard S524 latest edition “Installation of Fire Alarm Systems”.

3.1.4.2 Location of devices shown on Drawings are approximate and must be adjusted to site conditions. If location of existing device to be replaced is not properly centred in individual rooms, adjust to suit.

3.1.5 Mount detectors on ceiling as per CAN/ULC Standard S524 standard unless otherwise specified herein, with the minimum and maximum distances as required for the respective type of detector, at the highest point where variations in ceiling height exist. Do not mount detectors on sides, on undersides, or less than 600 mm (20”) from walls, beams, joints, ducts, open web steel joists, bulkheads or any structure projecting below actual ceiling height and less than 450 mm (18”) from air handling or heating outlets.

3.1.6 Should interference from obstruction, lamp positions, air outlet or heat radiating surfaces be encountered in locating any detector where shown, locate the detector as near as possible to the indicated position, clear of obstacles, to the satisfaction of the Consultant, but maintain a clear space of 600 mm (24”) on the ceiling, below and around.

3.1.6.1 Duct detectors to be mounted in supply air ducts unless otherwise indicated on the Drawings.

3.1.6.2 Mount end of line resistors beside last device. Document location of end of line resistors and place inside fire alarm control panel and in maintenance manuals. Provide PTouch labels on end of line faceplates indicating circuits contained within.

3.1.7 Locate all addressable monitor modules adjacent to equipment being monitored.

3.1.8 Locate all addressable control modules for motors adjacent to starters/motor control centres or building automation control panels as site directed.

3.1.9 Locate all addressable control modules not controlling motors within 3' of device being controlled, where practicable.

3.1.10 **Ancillary Devices**

3.1.10.1 Provide independent addressable control modules for each ancillary device shutdown.

3.1.10.2 Verify operating voltage of door hold open devices and magnetic locks supplied by door hardware contractor for tie into new system. Provide necessary transformation or relays.

3.1.10.3 Unless specified otherwise, power door hold-open devices from nearest unswitched lighting circuit.

3.1.10.4 Shutdown of fans to occur at starter separate from building automation controls. Where single point connections are provided to mechanical equipment, connect to fire alarm shutdown contact on mechanical equipment control panel.

3.1.10.5 Door hold open devices and latch retraction hardware to be installed in accordance with Ontario Building Code clause 3.1.8.12.

3.1.10.6 Magnetic locks to be installed in accordance with Ontario Building Code clause 3.4.6.16(4).

3.2 VERIFICATION AND CERTIFICATION OF FIRE ALARM EQUIPMENT

3.2.1 The Contractor is to provide a full set of Electrical Drawings and Specifications to the fire alarm system representative prior to starting the verification of the fire alarm system. Failure to do so may require the entire fire alarm system to be reverified. Fire alarm system representative to review drawings and provide comments to Consultant prior to commencing verification.

3.2.2 All construction work must be complete before verification of fire alarm system is started. Any modifications to the fire alarm installation after the verification

has been commenced will require the entire system to be reverified. Where partial occupancies occur, the fire alarm system for the area to be occupied (including control units) shall meet the requirements of this Standard. Upon system completion, those parts of the fire alarm system tested to this Standard shall be retested in accordance with the requirements of CAN/ULC-S536, Standard for the Inspection and Testing of Fire Alarm Systems, prior to the release of the Verification Report.

3.2.3 Fire alarm technician to review existing building prior to date of verification and review any existing conditions requiring repair. Submit report minimum one week before commencing verification. Consultant will review and issue appropriate instruction.

3.2.4 Where a field device is replaced, the device shall be verified in accordance with CAN/ULC-S537-04.

3.2.5 Testing of all flow switches is to be with actual water flow activation. Supervised valve switches and other supervisory zones to be tested by closing valves or replicating the abnormal condition.

3.2.6 The Contractor is to engage the services of the Fire Alarm manufacturer's representative to verify the fire alarm system in accordance with CAN/ULC-S537-04.

3.2.7 Test all voice communication systems throughout building. Adjust speaker taps as required to provide a minimum common intelligibility scale (CIS) score of 0.70. Evaluate each acoustically isolated space separately. Provide appropriate reports for review by Consultant. Reports to include room name and number, speaker tap wattage, SPL and CIS at no less than 2 locations per room.

3.2.8 During the period of inspection by the manufacturer's representative, make available to the manufacturer's representative as many electricians as designated by the manufacturer's representative to complete the verification within the specified time frame.

3.2.9 Contractor is to supply Consultant with a list of deficiencies indicating areas where installation deviates from ULC Standards or Ontario Building Code. This list will be reviewed and authorized or rejected by Consultant prior to acceptance of certificate.

3.2.10 **Inspection Certification:** On completion of the inspection and when all the above conditions have been complied with, the Contractor is to provide to the Consultant:

3.2.10.1 A verification report identical to Appendix C of CAN/ULC-S537 completed by the fire alarm manufacturer's technician. Document C1 from CAN/ULC-S537 must be signed and dated by the technician upon completion of the verification.

3.2.10.2 A certificate of verification confirming that the inspection has been completed showing the conditions upon which such inspection and certification have been rendered. Certificate must be free of conditions noted. No additional exceptions or conditions are acceptable.

3.2.10.3 Proof of liability insurance for the inspection.

3.2.10.4 A letter separate from the Verification Report stating “All door hold open devices, including latch retraction/release have been tested by the fire alarm verifier and are installed and working, in accordance with Ontario Building Code 3.1.8.12".

3.2.10.5 Provide ESA Inspection Certificate.

3.2.11 **Description of Fire Alarm System**

3.2.11.1 Upon completion of the project, provide to the Owner a copy of CAN/ULC-S536-13 Appendix E "Description of Fire Alarm System for Inspection and Test Procedures". Provide type written copy of this form and provide soft copy with maintenance manuals.

3.3 FIRE WATCH - ALTERNATIVE MEASURES FOR OCCUPANT FIRE SAFETY

3.3.1 In the event of any shutdown of fire protection equipment or part thereof, the Fire Department and building occupants/owner should be notified. Instructions should be posted as to alternate provisions or actions to be taken in case of an emergency. These provisions and actions should be acceptable to the Chief Fire Official and be in accordance with the accepted Fire Safety Plan.

3.3.2 An attempt to minimize the impact of inoperative equipment should be made (i.e. where portions of a sprinkler, fire alarm system and standpipe system are taken out of service, the remaining portions will be maintained). Assistance and direction for specific situations should be sought from the Fire Department and be in accordance with the accepted Fire Safety Plan.

3.3.3 Procedures to be followed in the event of shutdown of any part of a fire protection system are as follows:

3.3.3.1 Notify the Fire Department and the monitoring station. Give your name, address and a description of the work and when you expect it to be corrected. The Fire Department should be notified in writing of shutdowns longer than 24 h;

3.3.3.2 Post notices on all floors by elevators and at entrances, stating the work and when it is expected to be completed;

3.3.3.3 Unless noted otherwise in the Fire Safety Plan, have staff or other reliable person(s) patrol the affected area(s) at least once every hour; and

3.3.3.4 Notify the Fire Department, the fire signal receiving centre, and building occupants/owner when work has been completed and systems are operational.

3.4 ANCILLARY DEVICE OPERATION

3.4.1.1 All existing ancillary functions outside of the project scope are to remain.

3.4.1.2 Outputs to shutdown air handling equipment to activate only upon activation of any duct detector. General alarm is not to shut down air handling equipment.

3.5 INSPECTION COSTS

3.5.1 Include all costs involved with this inspection in the total Bid Price.

3.6 TESTING

3.6.1 Tests of the complete system in the presence of the Owner and the Consultant are to include:

3.6.1.1 Spot check of devices to ensure proper connections and supervision.

3.6.1.2 Operation of an alarm initiating device on each detection circuit is to verify the required operation of alarm devices, annunciators, etc.

3.6.1.3 Operation of all other alarm initiating devices in a convenient, silent method (buzzer, light, meter, etc.) are to ensure connection to the proper circuit and function of the device.

3.6.1.4 Live smoke or open flame are not to be used for testing.

3.6.1.5 Test each area in stages to match the Work Schedule.

3.6.1.6 Demonstrate to Consultant and Owner the operation of ancillary functions (ie maglock and door hardware release, elevator recall, etc).

3.6.2 Provide assistance to the Fire Inspection Department for testing a minimum of 25% of the installed field devices and up to 100% of sprinkler/ standpipe devices (supervised valves, flow switches, etc). Correct deficiencies and retest any devices or zones operating incorrectly as directed by the Fire Inspection Department.

3.6.3 **Integrated Systems Testing**

3.6.3.1 Provide Integrated Systems Testing as indicated in CAN/ULC-S1001-11 "Integrated Systems Testing of Fire Protection And Life Safety Systems. Refer to attached appendix for details regarding scope, various parties involved and the systems to be included.

3.6.3.2 Contractor to engage with a 3rd party commissioning type contractor to arrange for this work. In general, systems to be tested for proper integration with the fire alarm system are noted in CAN/ULC-S1001-11 and include but are not limited to elevators, cooking equipment fire suppression systems, hold-open devices, electromagnetic locks, smoke control systems, emergency generators, audio/visual and/or lighting controls, notification systems, sprinkler systems, standpipe systems, fire pumps, water supplies, water supply control valves, freeze protection systems, fixed fire suppression systems.

3.6.3.3 Submit the test plan and proposed reports to the Consultant for approval prior to scheduling the IST.

3.6.3.4 Provide completed IST reports upon completion of fire alarm verification and submission of verification reports and certificate. The completed IST reports shall each be sealed by a licensed Engineer with Professional Engineers Ontario who qualified to provide this Engineering service and insured in accordance with the requirements of Division C of the 2012 OBC. That individual will be designated herein as the Integrated Systems Testing Coordinator for the project. Submit their proof of Engineers liability insurance with the final report.

3.7 **TRAINING**

3.7.1 The Contractor shall provide 2 hours training for the complete operation of fire alarm system.

END OF SECTION

SECTION 28 31 00

A P P E N D I X

Integrated Systems Testing of Fire Protection Systems

Integrated Systems Testing of Fire Protection Systems

Contents

1. Integrated Testing Plan

With the increasingly complex and integrated nature of today's modern buildings, many facilities are equipped with many different components which must work in unison to form a functioning Fire Protection system. Unlike many other systems in buildings, non-functional integration of fire protection systems may go unnoticed by building occupants as these systems often function during an emergency condition only.

Traditionally each fire protection and life safety system is independently verified for correct operation, however, a single building-wide integrated test is required to confirm all systems work together. For example, doors in fire separations are often held open for convenience of building occupants during normal use of the building. However, these doors must close and latch during a fire event to prevent fire and smoke from spreading throughout a building. It is not uncommon for fire alarm verification to occur when door hardware is not fully installed. The fire alarm verification process includes verifying correct release of door hold-open magnets however does not necessarily confirm that the doors fully close and latch.

To ensure all components of fire protection and life safety systems operate as intended, a single Integrated Systems Test is required. The Integrated Systems Test includes testing integrated systems and devices only and does not include stand alone components of the building's fire protection and life safety systems. These stand-alone systems may include components and systems such as fire stopping, fire dampers, exit signs and standalone (not integrated) emergency lighting. Testing and verification for correct operation of these systems is separate from the Integrated Systems Test.

The Fire Alarm System forms the core of fire systems integration. This building is equipped with an addressable fire alarm system. The fire alarm system consists of addressable manual pull stations, automatic heat detectors, speaker and speaker strobes. Flow switches, supervised valves and other devices are fully supervised by the fire alarm. Ancillary devices include elevators, air handling equipment and door release devices.

Refer to the Integrated Testing Forms for Sequence of Operation, Testing Protocol and Procedures. The following systems are to be tested:

3.1 Fire Alarm

3.3 Air Handling Unit (AHU) Shutdown (Duct Detectors)

The Integrated Testing Coordinator may make recommendations, however design criteria for integration remains the responsibility of the respective Design Professional(s).

Integrated Testing Implementation is to occur while the building is occupied only with individuals actively involved in the Testing. Prior to testing, a debriefing meeting is to be held outlining safety protocols and procedures for the duration of the test. Safety protocols and procedures will consider time of day, time of year, number of participants and other factors which may remain unknown until the implementation phase. Ahead of testing, the Integrated Systems Coordinator will notify participants of the proposed intercommunications method between participants. Two-way radios, standalone overhead paging and

cellphones may be considered to alert participants. If equipped, use of fire alarm voice capabilities should be avoided as testing may prevent use during an emergency.

Should a condition arise during the Integrated Testing Implementation that places any participant(s) in danger or risks damaging the building, the Integrated Testing Implementation is to be stopped immediately. Once the abnormal condition is cleared, the Integrated Testing Implementation may proceed or may be cancelled and rescheduled for a later date. This decision is at the discretion of the Integrated Testing Coordinator.

Near the Integrated Testing Implementation one-year anniversary, a one-year integrated test is be conducted in accordance with the Integrated Testing Plan to ensure repeatability of the Sequence of Operations outlined in the Integrated Testing Report. Participation from Design Professional(s) and Authority Having Jurisdiction is not required. It is the responsibility of the Building Owner to arrange the one-year anniversary test.

1.1 Integrated Testing Implementation Phase

Upon engaging the Integrated Testing Coordinator, the following documentation is to be provided to the Integrated Testing Coordinator:

- Building floor plans
- Mechanical and Electrical Drawings
- Specifications
- Sequence of Operation Descriptions
- Mechanical and Electrical Riser Diagrams
- Manufacturer's operating and testing instructions
- Shop drawings for systems to be tested
- Documentation from the Authority Having Jurisdiction approving Alternative Solutions

Prior to implementing the Integrated Testing Plan, the following documentation is to be provided in writing to the Integrated Testing Coordinator:

- Confirmation from design processionals that the systems have been installed and tested in accordance with the design documents, and are ready for Integrated Fire Protection and Life Safety Systems Testing
- Confirmation from the installing contractor that the systems are installed and tested in accordance with the design documents, and are ready for Integrated Fire Protection and Life Safety Systems Testing
- Confirmation of inspection from ESA
- Confirmation of inspection from TSSA (elevators)
- Confirmation of implementation of occupant notification procedures
- Confirmation of implementation of alternate measures to ensure occupant safety

The Integrated Testing Coordinator shall provide sufficient notification of implementation to allow participation of the Integrated Testing Plan for:

- Authority Having Jurisdiction
- All Design Professionals listed on page 9

- All Installing Contractors listed on page 9
- Building Owner and/or Operator
- Verifying Parties
- Occupants
- Fire Signal Receiving Station (ULC monitoring company)

All tests are to be completed using functional operation of the device or system where possible. In cases involving non-restorable devices or systems, or where a test may result in harm to a person, device, system or building, simulation shall be permitted. Use of open flame to activate devices is not permitted.

Notify the Fire Department and Fire Signal Receiving Station (ULC monitoring company) prior to implementation. Upon commencement of testing, all Fire and Life Safety Systems shall be returned to functional operation and the Fire Department and Fire Signal Receiving Station shall be notified that testing is complete. Any deficiencies found by the Integrated Testing Coordinator are to be forwarded in writing to the Design Professionals for review and comment.

In the case of a failure of a test, the cause and severity of the failure will be considered before a course of action is developed. At the discretion of the Integrated Testing Coordinator, an attempt to rectify the cause of failure at time of testing may be considered, rectified and testing may proceed without a failed outcome. For example, a magnetic hold-open device may not be energized due to a breaker feeding the hold-open being in the off position, resulting in a door failing to remain held-open. Energizing the hold-open device will rectify the situation. A significant or systematic failure of a test will be documented, and the Installing Contractor will be required to rectify. After confirmation that the system is functioning by the Installing Contractor, a retest will be required.

The Integrated Testing Plan and completed Report are to be provided to the Building Owner and Authority Having Jurisdiction listed on page 6. A hard and soft copy are to be maintained on site.

2. Integrated Testing Report

Building Information

Building Name

Building Address

Building Owner

Owner's Representative

Municipality:

Number of Stories

Construction Type

Occupancy Classification

General Contact Information

Integrated Testing Coordinator (ITC) TBD

TBD

TBD

Authority Having Jurisdiction (AHJ) Name

Company

Phone no, email address

Integrated Testing Report Summary

Date Test Completed

Test Passed

General Comments

Integrated Systems Testing Report Accepted By

Integrated Testing Coordinator (ITC) _____

_____

Design Professional (architectural) _____

_____

Design Professional (mechanical) _____

_____

Design Professional (electrical) _____

_____

2.1 Summary of Systems Tested

System	YES	NO	Comments
Fire Alarm System	☐	☐	
Audio/Video and Lighting Control	☐	☐	
Sprinkler Systems	☐	☐	
Standpipe Systems	☐	☐	
Door-Hold Open and Latch Release Devices	☐	☐	
Electromagnetic Locks	☐	☐	
Smoke Fire Damper	☐	☐	
Air Handling Unit (AHU) Shutdown (Duct Detectors)	☐	☐	

2.2 Contact Information

Fire Alarm	
Design Professional	
Installing Contractor	
Verifying Party	

AV and Lighting Control: Corridor and Stair Lighting

Design Professional

Installing Contractor

Verifying Party

Sprinkler System

Design Professional

Installing Contractor

Verifying Party

Standpipe System

Design Professional

Installing Contractor

Verifying Party

Door- Hold Open and Latch Release Devices

Design Professional

Installing Contractor

Verifying Party

Electromagnetic Locks

Design Professional

Installing Contractor

Verifying Party

Smoke Fire Damper

Design Professional

Installing Contractor

Verifying Party

Air Handling Unit (AHU) Shutdown (Duct Detectors)

Design Professional

Installing Contractor

Verifying Party

3. Integrated Testing Forms

Integrated Test Forms

3.1 Fire Alarm

Sequence of Operation:

- Refer to manufacturers Sequence of Operations.
- Under normal conditions, fire alarm remains in ready state
- Initiating any automatic or manual pull station to place system in general alarm
- While in general alarm, fire signal receiving centre (FSRC) to receive alarm
- Activation of any supervisory device (supervised valve, etc) will cause fire alarm to annunciate supervisory on fire alarm zone and initiate supervisory transmission to FSRC
- An abnormal condition on the fire alarm panel (zone bypassed, malfunctioning device, etc) will cause fire alarm to annunciate trouble on fire alarm zone and initiate trouble transmission to FSRC

RETEST (YES OR NO): _____ DATE OF RETEST: _____

Test Scenario	YES	NO	Comments
Is Fire Alarm Verification report completed without deficiencies noted?	☐	☐	
Activate fire alarm from manual pull station. Does fire alarm enter alarm mode and correctly identify device?	☐	☐	
Activate fire alarm from manual pull station. Does FSRC report alarm?	☐	☐	
Activate supervised valve. Does FSRC report supervisory alarm?	☐	☐	
Bypass fire alarm zone. Does FSRC report trouble alarm?	☐	☐	
Reset all activated initiating devices, then fire alarm panel. Does ready light illuminate?	☐	☐	

Include the following documents in final Integrated Test Report:

- Fire Alarm Verification Report
- Fire Alarm Audibility Report
- Fire Alarm Verification Certificate
- Electrical Safety Authority Closeout Documentation

Accepted By	
Integrated Testing Coordinator	
Design Professional (electrical)	

3.2 Air Handling Unit (AHU) Shutdown (Duct Detectors)

(one sheet per AHU)

Sequence of Operation:

- Only systems that serve more than one story are required to shut down. AHUs serving single story remain under control of the Building Automation System (BAS)
- Under normal operation, AHU to operate based on schedule from BAS
- Upon general alarm, AHU to remain operational based on input from BAS
- Upon activation of associated duct detector, AHU to shut down regardless of inputs from BAS
- Upon reset of fire alarm, AHU to resume operation based on input from BAS

Air Handling Unit(s):

RETEST (YES OR NO): _____ DATE OF RETEST: _____

Test Scenario	YES	NO	Comments
Prior to test, is air handling unit fully operational?	☐	☐	
Activate fire alarm by manual pull station. Does Air Handling Unit remain operational?	☐	☐	
Activate duct smoke detector. Does Air Handling Unit shut down?	☐	☐	
Reset fire alarm panel. Does Air Handling Unit resume operation?	☐	☐	

Accepted By	
Integrated Testing Coordinator	
Design Professional (Electrical)	

tillmann
architects ruth
robinson